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The WONDERS of NATURE and the ACHIEVEMENTS OF MAN

With an Introduction by
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DEPT OF ZOOLOGY

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Man's Place in Nature

AND OTHER
ANTHROPOLOGICAL ESSAYS

By Thomas H. Huxley

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PREFACE.

I AM very well aware that the old are prone to regard their early performances with much more interest than their contemporaries of a younger generation are likely to take in them; moreover, I freely admit that my younger contemporaries might employ their time better than in perusing the three essays, written thirty-two years ago, which occupy the first place in this volume. This confession is the more needful, inasmuch as all the premises of the argument set forth in "Man's Place in Nature" and most of the conclusions deduced from them, are now to be met with among other well-established and, indeed, elementary truths, in the text-books.

Paradoxical as the statement may seem, however, it is just because every well-informed student of biology ought to be tempted to throw these essays, and especially the second, "On the Relations of Man to the Lower Animals," aside, as a fair mathematician might dispense with the reperusal of Cocker's arithmetic, that I think it worth while to reprint them; and entertain the hope that the story of their origin and early fate may not be devoid of a certain antiquarian interest, even if it possess no other.

In 1854, it became my duty to teach the principles of biological science with especial reference to paleontology. The first result of addressing myself to the business I had taken in hand, was the discovery of my own lamentable ignorance in respect of many parts of the vast field of knowledge through which I had undertaken to guide others. The second result was a resolution to amend this state of things to the best of my ability; to which end, I surveyed the ground; and having made out what were the main positions to be captured, I came to the conclusion that I must try to carry them by concentrating all the energy I possessed upon each in turn. So I set to work to know some-

thing of my own knowledge of all the various disciplines included under the head of Biology; and to acquaint myself, at first hand, with the evidence for and against the extant solutions of the greater problems of that science. I have reason to believe that wise heads were shaken over my apparent divagations—now into the province of Physiology or Histology, now into that of Comparative Anatomy, of Development, of Zoology, of Paleontology, or of Ethnology. But even at this time, when I am, or ought to be, so much wiser, I really do not see that I could have done better. And my method had this great advantage; it involved the certainty that somebody would profit by my effort to teach properly. Whatever my hearers might do, I myself always learned something by lecturing. And to those who have experience of what a heart-breaking business teaching is — how much the can't-learns and won't-learns and don't-learns predominate over the do-learns — will understand the comfort of that reflection.

Among the many problems which came under my consideration, the position of the human species in zoological classification was one of the most serious. Indeed, at that time, it was a burning question in the sense that those who touched it were almost certain to burn their fingers severely. It was not so very long since my kind friend Sir William Lawrence, one of the ablest men whom I have known, had been well-nigh ostracized for his book, "On Man," which now might be read in a Sunday-school without surprising anybody; it was only a few years, since the electors to the chair of Natural History in a famous northern university had refused to invite a very distinguished man to occupy it because he advocated the doctrine of the diversity of species of mankind, or what was called "polygeny." Even among those who considered man from the point of view, not of vulgar prejudice, but of science, opinions lay poles asunder. Linnæus had taken one view, Cuvier another; and, among my senior contemporaries, men like Lyell, regarded by many as revolutionaries of the deepest dye, were strongly opposed to anything which tended to break down the barrier between man and the rest of the animal world.

My own mind was by no means definitely made up about this matter when, in the year 1857, a paper was read before the Linnæan Society "On the Characters, Principles of Division and

Primary Groups of the Class Mammalia," in which certain anatomical features of the brain were said to be "peculiar to the genus *Homo*," and were made the chief ground for separating that genus from all other mammals, and placing him in a division, "Archencephala," apart from, and superior to, all the rest. As these statements did not agree with the opinions I had formed, I set to work to reinvestigate the subject; and soon satisfied myself that the structures in question were not peculiar to Man, but were shared by him with all the higher and many of the lower apes. I embarked in no public discussion of these matters; but my attention being thus drawn to them, I studied the whole question of the structural relations of Man to the next lower existing forms, with much care. And, of course, I embodied my conclusions in my teaching.

Matters were at this point, when "The Origin of Species" appeared. The weighty sentence "Light will be thrown on the origin of man and his history" (1st ed. p. 488) was not only in full harmony with the conclusions at which I had arrived, respecting the structural relations of apes and men, but was strongly supported by them. And inasmuch as Development and Vertebrate Anatomy were not among Mr. Darwin's many specialities, it appeared to me that I should not be intruding on the ground he had made his own, if I discussed this part of the general question. In fact, I thought that I might probably serve the cause of evolution by doing so.

Some experience of popular lecturing had convinced me that the necessity of making things plain to uninstructed people, was one of the very best means of clearing up the obscure corners in one's own mind. So, in 1860, I took the Relation of Man to the Lower Animals, for the subject of the six lectures to working men which it was my duty to deliver. It was also in 1860, that this topic was discussed before a jury of experts, at the meeting of the British Association at Oxford; and, from that time, a sort of running fight on the same subject was carried on, until it culminated at the Cambridge meeting of the Association in 1862, by my friend Sir W. Flower's public demonstration of the existence in the apes of those cerebral characters which had been said to be peculiar to man.

"Magna est veritas et prævalebit!" Truth is great, certainly, but, considering her greatness, it is curious what a long time

she is apt to take about prevailing. When, towards the end of 1862, I had finished writing "Man's Place in Nature," I could say with a good conscience, that my conclusions "had not been formed hastily or enunciated crudely." I thought I had earned the right to publish them and even fancied I might be thanked, rather than reproved, for so doing. However, in my anxiety to promulgate nothing erroneous, I asked a highly competent anatomist and very good friend of mine to look through my proofs and, if he could, point out any errors of fact. I was well pleased when he returned them without criticism on that score; but my satisfaction was speedily dashed by the very earnest warning, as to the consequences of publication, which my friend's interest in my welfare led him to give. But as I have confessed elsewhere, when I was a young man, there was just a little — a mere *soupçon* — in my composition of that tenacity of purpose which has another name! and I felt sure that all the evil things prophesied would not be so painful to me as the giving up that which I had resolved to do, upon grounds which I conceived to be right. So the book came out; and I must do my friend the justice to say that his forecast was completely justified. The Boreas of criticism blew his hardest blasts of misrepresentation and ridicule for some years; and I was even as one of the wicked. Indeed, it surprises me, at times, to think how any one who had sunk so low could since have emerged into, at any rate, relative respectability. Personally, like the non-corvine personages in the Ingoldsby legend, I did not feel "one penny the worse." Translated into several languages, the book reached a wider public than I had ever hoped for; being largely helped, I imagine, by the Ernulphine advertisements to which I have referred. It has had the honour of being freely utilized, without acknowledgment, by writers of repute; and, finally, it achieved the fate, which is the euthanasia of a scientific work, of being inclosed among the rubble of the foundations of later knowledge and forgotten.

To my observation, human nature has not sensibly changed during the last thirty years. I doubt not that there are truths as plainly obvious and as generally denied, as those contained in "Man's Place in Nature," now awaiting enunciation. If there is a young man of the present generation, who has taken as much trouble as I did to assure himself that they are truths, let him

come out with them, without troubling his head about the barking of the dogs of St. Ernulphus. "Veritas prævalebit"—some day; and, even if she does not prevail in his time, he himself will be all the better and the wiser for having tried to help her. And let him recollect that such great reward is full payment for all his labour and pains.

"Man's Place in Nature," perhaps, may still be useful as an introduction to the subject; but, as any interest which attaches to it must be mainly historical, I have thought it right to leave the essays untouched. The history of the long controversy about the structure of the brain, following upon the second dissertation, in the original edition, however, is omitted. The verdict of science has long been pronounced upon the questions at issue; and no good purpose can be served by preserving the memory of the details of the suit.

In many passages, the reader who is acquainted with the present state of science, will observe much room for addition; but, in all cases, the supplements required, are, I believe, either indifferent to the argument or would strengthen it.

THOMAS H. HUXLEY.

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MAN'S PLACE IN NATURE.

I.

ON THE NATURAL HISTORY OF THE MAN-LIKE APES.

ANCIENT traditions, when tested by the severe process of modern investigation, commonly enough fade away into mere dreams: but it is singular how often the dream turns out to have been a half-waking one, presaging a reality. Ovid foreshadowed the discoveries of the geologist: the Atlantis was an imagination, but Columbus found a western world: and though the quaint forms of Centaurs and Satyrs have an existence only in the realms of art, creatures approaching man more nearly than they in essential structure, and yet as thoroughly brutal as the goat's or horse's half of the mythical compound, are now not only known, but notorious.

I have not met with any notice of one of these MAN-LIKE APES of earlier date than that contained in Pigafetta's "Description of the kingdom of Congo,"* drawn up from the notes of a Portuguese sailor, Eduardo Lopez, and published in 1598. The tenth chapter of this work is entitled "De Animalibus quæ in hac provincia reperiuntur," and contains a brief passage to the effect that "in the Songan country, on the banks of the Zaire, there are multitudes of apes, which afford great delight to the nobles by imitating human gestures." As this might apply to almost any kind of apes, I should have thought little of it, had not the brothers De Bry, whose engravings illustrate the work, thought fit, in their eleventh "Argumentum," to figure two of these "Simiæ magnatum deliciæ." So much of the plate as contains these apes is faithfully copied in the woodcut (Fig. 1), and it will be observed that they are tail-less, long-armed, and large-eared; and about the size of Chimpanzees. It may be that these

* REGNUM CONGO: hoc est VERA DESCRIPTIO REGNI AFRICANI QUOD TAM AB INCOLIS QUAM LUSITANIS CONGUS APPELLATUR, per Philippum Pigafettam, olim ex Edoardo Lopez acroamatis lingua Italica excerpta, num Latio sermone donata ab August. Cassiod. Reinio. Iconibus et imaginibus rerum memorabilium quasi vivis, opera et industria Joan. Theodori et Joan, Israelis de Bry, fratrum exornata. Francofurti, MDXCVIII.

apes are as much figments of the imagination of the ingenious brothers as the winged, two-legged, crocodile-headed dragon which adorns the same plate; or, on the other hand, it may be that the artists have constructed their drawings from some essentially faithful description of a Gorilla or a Chimpanzee. And, in either case, though these figures are worth a passing notice, the oldest trustworthy and definite accounts of any animal of this kind date from the 17th century, and are due to an Englishman.

The first edition of that most amusing old book, "Purchas his Pilgrimage," was published in 1613, and therein are to be found many references to the statements of one whom Purchas terms "Andrew Battell (my neere neighbour, dwelling at Leigh in Essex)

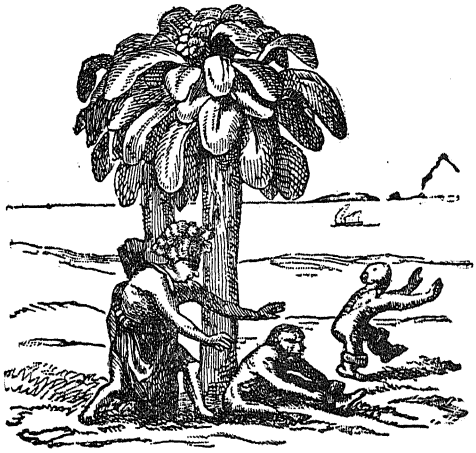


Fig. 1.—Simiæ magnatum deliciæ.—De Bry, 1598.

who served under Manuel Silvera Perera, Governor under the King of Spaine, at his city of Saint Paul, and with him went farre into the countrey of Angola"; and again, "my friend, Andrew Battle, who lived in the kingdom of Congo many yeares," and who, "upon some quarrell betwixt the Portugals (among whom he was a sergeant of a band) and him, lived eight or nine moneths in the woodes." From this weatherbeaten old soldier, Purchas was amazed to hear "of a kinde of Great Apes, if they might so be termed, of the height of a man, but twice as bigge in feature of their limmes, with strength proportionable, hairie all over, otherwise altogether like men and women in their whole bodily shape.*

* "Except this that their legges had no calves."—[Ed. 1626.] And in a marginal note, "These great apes are called Pongo's."

They lived on such wilde fruits as the trees and woods yielded, and in the night time lodged on the trees."

This extract is, however, less detailed and clear in its statements than a passage in the third chapter of the second part of another work — "Purchas his Pilgrimes," published in 1625, by the same author — which has been often, though hardly ever quite rightly, cited. The chapter is entitled, "The strange adventures of Andrew Battell, of Leigh in Essex, sent by the Portugals prisoner to Angola, who lived there and in the adioining regions neere eighhteene yeeres." And the sixth section of this chapter is headed —"Of the Provinces of Bongo, Calongo, Mayombe, Manikesocke, Motimbas: of the Ape Monster Pongo, their hunting: Idolatries; and divers other observations."

"This province (Calongo) toward the east bordereth upon Bongo, and toward the north upon Mayombe, which is nineteen leagues from Longo along the coast.

"This province of Mayombe is all woods and groves, so overgrowne that a man may travaile twentie days in the shadow without any sunne or heat. Here is no kind of corne nor graine, so that the people liveth onely upon plantanes and roots of sundrie sorts, very good; and nuts; nor any kinde of tame cattell, nor hens.

"But they have great store of elephants' flesh, which they greatly esteeme, and many kinds of wild beasts; and great store of fish. Here is a great sandy bay, two leagues to the northward of Cape Negro,* which is the port of Mayombe. Sometimes the Portugals lade logwood in this bay. Here is a great river, called Banna: in the winter it hath no barre, because the generall winds cause a great sea. But when the sunne hath his south declination, then a boat may goe in; for then it is smooth because of the raine. This river is very great, and hath many ilands and people dwelling in them. The woods are so covered with baboones, monkies, apes, and parrots, that it will feare any man to travaile in them alone. Here are also two kinds of monsters, which are common in these woods, and very dangerous.

"The greatest of these two monsters is called Pongo in their language, and the lesser is called Engeco. This Pongo is in all proportion like a man; but that he is more like a giant in stature than a man; for he is very tall, and hath a man's face, hollow-eyed, with long haire upon his browes. His face and eares are without haire, and his hands also. His bodie is full of haire, but not very thicke; and it is of a dunnish colour.

"He differeth not from a man but in his legs; for they have no calfe. Hee goeth alwaies upon his legs, and carrieth his hands clasped in the nape of his necke when he goeth upon the ground. They sleepe in the trees, and build shelters for the raine. They feed upon fruit that they find in the woods, and upon nuts, for they eate no kind of flesh. They

* *Purchas' note.*—Cape Negro is in 16 degrees south of the line.

cannot speake, and have no understanding more than a beast. The people of the countrie, when they travaile in the woods make fires where they sleepe in the night; and in the morning, when they are gone, the Pongoes will come and sit about the fire till it goeth out; for they have no understanding to lay the wood together. They goe many together and kill many negroes that travaile in the woods. Many times they fall upon the elephants which come to feed where they be, and so beate them with their clubbed fists, and pieces of wood, that they will runne roaring away from them. Those Pongoes are never taken alive because they are so strong, that ten men cannot hold one of them; but yet they take many of their young ones with poisoned arrowes.

"The young Pongo hangeth on his mother's belly with his hands fast clasped about her, so that when the countrie people kill any of the females they take the young one, which hangeth fast upon his mother.

"When they die among themselves, they cover the dead with great heaps of boughs and wood, which is commonly found in the forest." *

It does not appear difficult to identify the exact region of which Battell speaks. Longo is doubtless the name of the place usually spelled Loango on our maps. Mayombe still lies some nineteen leagues northward from Loango, along the coast; and Cilongo or Kilonga, Manikesocke, and Motimbas are yet registered by geographers. The Cape Negro of Battell, however, cannot be the modern Cape Negro in 16° S., since Loango itself is in 4° S. latitude. On the other hand, the "great river called Banna" corresponds very well with the "Camma" and "Fernand Vas," of modern geographers, which form a great delta on this part of the African coast.

Now this "Camma" country is situated about a degree and a half south of the Equator, while a few miles to the north of the line lies the Gaboon, and a degree or so north of that, the Money River — both well known to modern naturalists as localities where the largest of man-like Apes has been obtained. Moreover, at the present day, the word Engeco, or N'schego, is applied by the natives of these regions to the smaller of the two great Apes which inhabit them; so that there can be no rational doubt that Andrew Battell spoke of that which he knew of his own knowledge, or, at any rate, by immediate report from the natives of Western Africa. The "Engeco," however, is that "other monster" whose

* *Purchas' marginal note*, p. 982:—"The Pongo is a giant ape. He told me in conference with him, that one of these Pongoes tooke a negro boy of his which lived a moneth with them. For they hurt not those which they surprise at unawares, except they look on them; which he avoyded. He said their highth was like a man's but their bignesse twice as great. I saw the negro boy. What the other monster should be he hath forgotten to relate; and these papers came to my hand since his death, which, otherwise, in my often conferences, I might have learned. Perhaps he meaneth the Pigmy Pongo killers mentioned."

nature Battell "forgot to relate," while the name "Pongo"—applied to the animals whose characters and habits are so fully and carefully described—seems to have died out, at least in its primitive form and signification. Indeed, there is evidence that not only in Battell's time, but up to a very recent date, it was used in a totally different sense from that in which he employs it.

For example, the second chapter of Purchas' work, which I have just quoted, contains "A Description and Historical Declaration of the Golden Kingdom of Guinea, &c. &c. Translated from the Dutch, and compared also with the Latin," wherein it is stated (p. 986) that—

"The River Gaboon lyeth about fifteen miles northward from Rio de Angra, and eight miles northward from Cape de Lope Gonsalvez (Cape Lopez), and is right under the Equinoctial line, about fifteene miles from St. Thomas, and is a great land, well and easily to be knowne. At the mouth of the river there lieth a sand, three or foure fathoms deepe, whereon it beateth mightily with the streame which runneth out of the river into the sea. This river, in the mouth thereof, is at least four miles broad; but when you are about the Iland called *Pongo*, it is not above two miles broad. . . . On both sides the river there standeth many trees. . . . The Iland called *Pongo*, which hath a monstrous high hill."

The French naval officers, whose letters are appended to the late M. Isidore Geoff. Saint Hilaire's excellent essay on the Gorilla,* note in similar terms the width of the Gaboon, the trees that line its banks down to the water's edge, and the strong current that sets out of it. They describe two islands in its estuary;—one low, called Perroquet; the other high, presenting three conical hills, called Coniquet; and one of them, M. Franquet, expressly states that, formerly, the Chief of Coniquet was called *Meni-Pongo*, meaning thereby Lord of *Pongo;* and that the *N'Pongues* (as, in agreement with Dr. Savage, he affirms the natives call themselves) term the estuary of the Gaboon itself *N'Pongo*.

It is so easy, in dealing with savages, to misunderstand their applications of words to things, that one is at first inclined to suspect Battell of having confounded the name of this region, where his "greater monster" still abounds, with the name of the animal itself. But he is so right about other matters (including the name of the "lesser monster") that one is loth to suspect the old traveller of error; and, on the other hand, we shall find

* *Archives du Museum*, Tome X.

that a voyager of a hundred years' later date speaks of the name "Boggoe," as applied to a great Ape, by the inhabitants of quite another part of Africa — Sierra Leone.

But I must leave this question to be settled by philologers and travellers; and I should hardly have dwelt so long upon it except for the curious part played by this word "*Pongo*" in the later history of the man-like Apes.

The generation which succeeded Battell saw the first of the man-like Apes which was ever brought to Europe, or, at any rate, whose visit found a historian. In the third book of Tulpius' "Observationes Medicæ," published in 1641, the 56th chapter or section is devoted to what he calls *Satyrus indicus*, "called by the Indians Orang-autang or Man-of-the-Woods, and by the Africans



Fig. 2.—The Orang of Tulpius, 1641.

Quoias Morrou." He gives a very good figure, evidently from the life, of the specimen of this animal, "nostra memoria ex Angolâ delatum," presented to Frederick Henry Prince of Orange. Tulpius says it was as big as a child of three years old, and as stout as one of six years: and that its back was covered with black hair. It is plainly a young Chimpanzee.

In the meanwhile, the existence of other, Asiatic, man-like Apes became known, but at first in a very mythical fashion. Thus Bontius (1658) gives an altogether fabulous and ridiculous account and figure of an animal which he calls "Orang-outang";

and though he says "vidi Ego cujus effigiem hic exhibeo," the said effigies (see Fig. 6 for Hoppius' copy of it) is nothing but a very hairy woman of rather comely aspect, and with proportions and feet wholly human. The judicious English anatomist, Tyson, was justified in saying of this description by Bontius, "I confess I do mistrust the whole representation."

It is to the last-mentioned writer, and his coadjutor Cowper, that we owe the first account of a man-like ape which has any

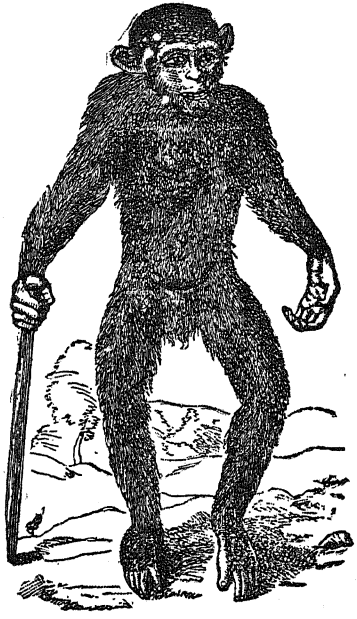


Fig. 3.—The "Pygmie" reduced from Tyson's figure 1, 1699.

pretensions to scientific accuracy and completeness. The treatise entitled, "*Orang-outang, sive Homo Sylvestris;* or the Anatomy of a Pygmie compared with that of a *Monkey,* an *Ape,* and a *Man,*" published by the Royal Society in 1699, is, indeed, a work of remarkable merit, and has, in some respects, served as a model to subsequent inquirers. This "Pygmie," Tyson tells us "was brought from Angola, in Africa; but was first taken a great deal higher up the country"; its hair "was of a coal-black colour and straight," and "when it went as a quadruped on all four, 'twas awkwardly; not placing the palm of the hand flat to the ground, but it walk'd upon its knuckles, as I observed it to do when weak

and had not strength enough to support its body,"—"From the top of the head to the heel of the foot, in a straight line, it measured twenty-six inches."

These characters, even without Tyson's good figure (Figs. 3 and 4), would have been sufficient to prove his "Pygmie" to be a young Chimpanzee. But the opportunity of examining the skeleton of the very animal Tyson anatomised having most unexpectedly presented itself to me, I am able to bear independent testimony to its being a veritable *Troglodytes niger*,* though still



Fig. 4.—The "Pygmie" reduced from Tyson's figure 2, 1699.

very young. Although fully appreciating the resemblances between his Pygmie and Man, Tyson by no means overlooked the differences between the two, and he concludes his memoir by summing up first, the points in which "the Ourang-outang or Pygmie

*I am indebted to Dr. Wright, of Cheltenham, whose paleontological labours are so well known, for bringing this interesting relic to my knowledge. Tyson's granddaughter, it appears, married Dr. Allardyce, a physician of repute in Cheltenham, and brought, as part of her dowry, the skeleton of the "Pygmie." Dr. Allardyce presented it to the Cheltenham Museum, and, through the good offices of my friend Dr. Wright, the authorities of the Museum have permitted me to borrow, what is, perhaps, its most remarkable ornament.

more resembled a Man than Apes and Monkeys do," under forty-seven distinct heads; and then giving, in thirty-four similar brief paragraphs, the respects in which "the Ourang-outang or Pygmie differ'd from a man and resembled more the Ape and Monkey kind."

After a careful survey of the literature of the subject extant in his time, our author arrives at the conclusion that his "Pygmie" is identical neither with the Orangs of Tulpius and Bontius, nor with the Quoias Morrou of Dapper (or rather of Tulpius), the Barris of d'Arcos, nor with the Pongo of Battell; but that it is a species of ape probably identical with the Pygmies of the Ancients, and, says Tyson, though it "does so much resemble



Fig. 5.—Facsimile of William Smith's figure of the "Mandrill," 1744.

a Man in many of its parts, more than any of the ape kind, or any other *animal* in the world, that I know of: yet by no means do I look upon it as the product of a *mixt* generation—'tis a *Brute-Animal sui generis,* and a particular *species of Ape.*"

The name of "Chimpanzee," by which one of the African Apes is now so well known, appears to have come into use in the first half of the eighteenth century, but the only important addition made, in that period, to our acquaintance with the man-like apes of Africa is contained in "A New Voyage to Guinea," by William Smith, which bears the date 1744.

In describing the animals of Sierra Leone, p. 51, this writer says:—

"I shall next describe a strange sort of animal, called by the white men in this country Mandrill,* but why it is so called I know not, nor did I ever hear the name before, neither can those who call them so tell, except it be for their near resemblance of a human creature, though nothing at all like an Ape. Their bodies, when full grown, are as big in circumstance as a middle-sized man's — their legs much shorter, and their feet larger; their arms and hands in proportion. The head is monstrously big, and the face broad and flat, without any other hair but the eyebrows; the nose very small, the mouth wide, and the lips thin. The face, which is covered by a white skin, is monstrously ugly, being all over wrinkled as with old age; the teeth broad and yellow; the hands have no more hair than the face, but the same white skin, though all the rest of the body is covered with long black hair, like a bear. They never go upon all-fours, like apes; but cry, when vexed or teased, just like children. . . .

"When I was at Sherbro, one Mr. Cummerbus, whom I shall have occasion hereafter to mention, made me a present of one of these strange animals, which are called by the natives Boggoe: it was a she-cub, of six months' age, but even then larger than a Baboon. I gave it in charge to one of the slaves, who knew how to feed and nurse it, being a very tender sort of animal; but whenever I went off the deck the sailors began to teaze it — some loved to see its tears and hear it cry; others hated its snotty nose; one who hurt it, being checked by the negro that took care of it, told the slave he was very fond of his country-woman, and asked him if he should not like her for a wife? To which the slave very readily replied, 'No, this no my wife; this a white woman — this fit wife for you.' This unlucky wit of the negro's, I fancy, hastened its death, for next morning it was found dead under the windlass."

William Smith's "Mandrill," or "Boggoe," as his description and figure testify, was, without doubt, a Chimpanzee.

Linnæus knew nothing, of his own observation, of the man-like Apes of either Africa or Asia, but a dissertation by his pupil Hoppius in the "Amœnitates Academicæ" (VI. "Anthropomorpha") may be regarded as embodying his views respecting these animals.

The dissertation is illustrated by a plate of which the accompanying woodcut, Fig. 6, is a reduced copy. The figures are

* "Mandrill" seems to signify a "man-like ape," the word "Drill" or "Dril" having been anciently employed in England to denote an Ape or Baboon. Thus in the fifth edition of Blount's "*Glossographia*, or a Dictionary interpreting the hard words of whatsoever language now used in our refined English tongue . . . very useful for all such as desire to understand what they read," published in 1681, I find, "Dril — a stonecutter's tool wherewith he bores little holes in marble, &c. Also a large overgrown Ape and Baboon, so called." "Drill" is used in the same sense in Charleston's *Onomasticon Zoicon*, 1668. The singular etymology of the word given by Buffon seems hardly a probable one.

entitled (from left to right) 1. *Troglodyta Bontii;* 2. *Lucifer Aldrovandi;* 3. *Satyrus Tulpii;* 4. *Pygmæus Edwardi.* The first is a bad copy of Bontius' fictitious "Ourang-outang," in whose existence, however, Linnæus appears to have fully believed; for in the standard edition of the "Systema Naturæ," it is enumerated as a second species of Homo; "H. nocturnus." *Lucifer Aldrovandi* is a copy of a figure in Aldrovandus, "De Quadrupedibus digitatis viviparis," Lib. 2, p. 249 (1645) entitled "Cercopithecus formæ raræ *Barbilius* vocatus et originem a china ducebat." Hoppius is of opinion that this may be one of that cat-tailed people, of whom Nicolaus Köping affirms that they eat a boat's crew, "gubernator navis" and all! In the "Systema Naturæ" Linnæus calls it in a note *Homo caudatus,* and seems inclined to regard it as a third species of man. According to Temminck, *Satyrus Tulpii* is a copy of the figure of a Chimpanzee published by



Fig. 6.—The Anthropomorpha of Linnæus.

Scotin in 1738, which I have not seen. It is the *Satyrus indicus* of the Systema Naturæ," and is regarded by Linnæus as possibly a distinct species from *Satyrus sylvestris.* The last, named *Pygmæus Edwardi,* is copied from the figure of a young "Man of the Woods," or true Orang-Utan, given in Edwards' "Gleanings of Natural History" (1758).

Buffon was more fortunate than his great rival. Not only had he the rare opportunity of examining a young Chimpanzee in the living state, but he became possessed of an adult Asiatic man-like Ape—the first and the last adult specimen of any of these animals brought to Europe for many years. With the valuable assistance of Daubenton, Buffon gave an excellent de-

scription of this creature, which, from its singular proportions, he termed the long-armed Ape, or Gibbon. It is the modern *Hylobates lar.*

Thus when, in 1766, Buffon wrote the fourteenth volume of his great work, he was personally familiar with the young of one kind of African man-like Ape, and with the adult of an Asiatic species — while the Orang-Utan and the Mandrill of Smith were known to him by report. Furthermore, the Abbé Prevost had translated a good deal of Purchas' "Pilgrims" into French, in his "Histoire générale des Voyages" (1748), and there Buffon found a version of Andrew Battell's account of the Pongo and the Engeco. All these data Buffon attempts to weld together into harmony in this chapter entitled "Les Orang-outangs ou le Pongo et le Jocko." To this title the following note is appended:—

"Orang-outang nom de cet animal aux Indes orientales: Pongo nom de cet animal à Lowando Province de Congo.

"Jocko, Enjocko, nom de cet animal à Congo que nous avons adopté. *En* est l'article que nous avons retranché."

Thus it was that Andrew Battell's "Engeco" became metamorphosed into "Jocko," and, in the latter shape, was spread all over the world, in consequence of the extensive popularity of Buffon's works. The Abbé Prevost and Buffon between them however, did a good deal more disfigurement to Battell's sober account than "cutting off an article." Thus Battell's statement that the Pongos "cannot speake, and have no understanding more than a beast," is rendered by Buffon "qu'il ne peut parler *quoiqu'il ait plus d'entendement que les autres animaux;*" and again, Purchas' affirmation, "He told me in conference with him, that one of these Pongos tooke a negro boy of his which lived a moneth with them," stands in the French version, "un pongo lui enleva un petit negre qui passa un *an* entier dans la société de ces animaux."

After quoting the account of the great Pongo, Buffon justly remarks, that all the "Jockos" and "Orangs" hitherto brought to Europe were young; and he suggests that, in their adult condition, they might be as big as the Pongo or "great Orang;" so that, provisionally, he regarded the Jockos, Orangs, and Pongos as all of one species. And perhaps this was as much as the state of knowledge at the time warranted. But how it came about that Buffon failed to perceive the similarity of Smith's "Mandrill" to his own "Jocko," and confounded the former with so totally different a creature as the blue-faced Baboon, is not so easily intelligible.

Twenty years later Buffon changed his opinion,* and expressed his belief that the Orangs constituted a genus with two species, — a large one, the Pongo of Battell, and a small one, the Jocko: that the small one (Jocko) is the East Indian Orang; and that the young animals from Africa, observed by himself and Tulpius, are simply young Pongos.

In the meanwhile, the Dutch naturalist, Vosmaer, gave, in 1778, a very good account and figure of a young Orang, brought alive to Holland, and his countryman, the famous anatomist, Peter Camper, published (1779) an essay on the Orang-Utan of similar value to that of Tyson on the Chimpanzee. He dissected several females and a male, all of which, from the state of their skeleton and their dentition, he justly supposes to have been young. However, judging by the analogy of man, he concludes that they could not have exceeded four feet in height in the adult condition. Furthermore, he is very clear as to the specific distinctness of the true East Indian Orang.

"The Orang," says he, "differs not only from the Pigmy of Tyson and from the Orang of Tulpius by its peculiar colour and its long toes, but also by its whole external form. Its arms, its hands, and its feet are longer, while the thumbs, on the contrary, are much shorter, and the great toes much smaller in proportion."† And again, "The true Orang, that is to say, that of Asia, that of Borneo, is consequently not the Pithecus, or tail-less Ape, which the Greeks, and especially Galen, have described. It is neither the Pongo nor the Jocko, nor the Orang of Tulpius, nor the Pigmy of Tyson,— *it is an animal of a peculiar species,* as I shall prove in the clearest manner by the organs of voice and the skeleton in the following chapters" (*l. c.* p. 64).

A few years later, M. Radermacher, who held a high office in the Government of the Dutch dominions in India, and was an active member of the Batavian Society of Arts and Sciences, published in the second part of the Transactions of that Society‡ a Description of the Island of Borneo, which was written between the years 1779 and 1781, and, among much other interesting matter, contains some notes upon the Orang. The small sort of Orang-Utan, viz. that of Vosmaer and of Edwards, he says, is found only in Borneo, and chiefly about Banjermassing, Mampauwa, and Landak. Of these he had seen some fifty during his residence in the Indies; but none exceeded 2½ feet in length. The larger sort, often regarded as a chimæra, continues Rader-

* *Histoire Naturelle*, Suppl. Tome 7ème, 1789.
† Camper, *Œuvres*, i., p. 56.
‡ *Verhandelingen van het Bataviaasch Genootschap*. Tweede Deel. Derde Druk. 1826.

macher, would perhaps long have remained so, had it not been for the exertions of the Resident at Rembang, M. Palm, who, on returning from Landak towards Pontiana, shot one, and forwarded it to Batavia in spirit, for transmission to Europe.

Palm's letter describing the capture runs thus:—"Herewith I send your Excellency, contrary to all expectation (since long ago I offered more than a hundred ducats to the natives for an Orang-Utan of four or five feet high) an Orang which I heard of this morning about eight o'clock. For a long time we did our best to take the frightful beast alive in the dense forest about half way to Landak. We forgot even to eat, so anxious were we not to let him escape; but it was necessary to take care that he did not revenge himself, as he kept continually breaking off heavy pieces of wood and green branches, and dashing them at us. This game lasted till four o'clock in the afternoon, when we determined to shoot him; in which I succeeded very well, and indeed better than I ever shot from a boat before; for the bullet went just into the side of his chest, so that he was not much damaged. We got him into the prow still living, and bound him fast, and next morning he died of his wounds. All Pantiana came on board to see him when we arrived." Palm gives his height from the head to the heel as 49 inches.

A very intelligent German officer, Baron Von Wurmb, who at this time held a post in the Dutch East India service, and was Secretary of the Batavian Society, studied this animal, and his careful description of it, entitled "Beschrijving van der Groote Borneosche Orang-outang of de Oost-Indische Pongo;" is contained in the same volume of the Batavian Society's Transactions. After Von Wurmb had drawn up his description he states, in a letter dated Batavia, Feb. 18, 1781,* that the specimen was sent to Europe in brandy to be placed in the collection of the Prince of Orange; "unfortunately," he continues, "we hear that the ship has been wrecked." Von Wurmb died in the course of the year 1781, the letter in which this passage occurs being the last he wrote; but in his posthumous papers, published in the fourth part of the Transactions of the Batavian Society, there is a brief description, with measurements, of a female Pongo four feet high.

Did either of these original specimens, on which Von Wurmb's descriptions are based, ever reach Europe? It is commonly supposed that they did; but I doubt the fact. For, appended to the memoir "De l'Ourang-outang," in the collected edition of Cam-

* "Briefe des Herrn v. Wurmb und des H. Baron von Wollzogen. Gotha, 1794."

per's works, tome i., pp. 64-66, is a note by Camper himself, referring to Von Wurmb's papers, and continuing thus: — "Heretofore, this kind of ape had never been known in Europe. Radermacher has had the kindness to send me the skull of one of these animals, which measured fifty-three inches, or four feet five inches, in height. I have sent some sketches of it to M. Soemmering at Mayence, which are better calculated, however, to give an idea of the form than of the real size of the parts."

These sketches have been reproduced by Fischer and by Lucæ, and bear date 1783, Soemmering having received them in 1784. Had either of Von Wurmb's specimens reached Holland, they would hardly have been unknown at this time to Camper, who, however, goes on to say: — "It appears that since this, some more

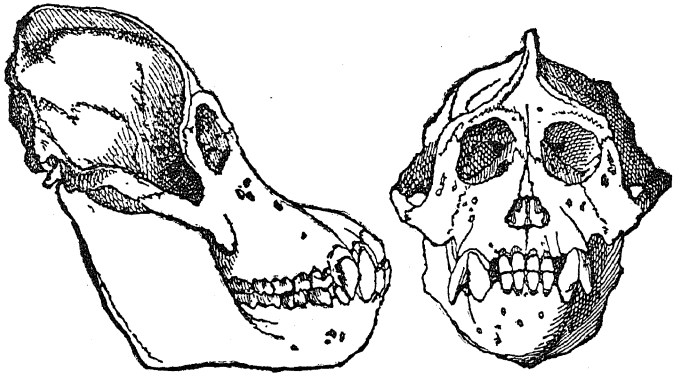


Fig. 7.—The Pongo Skull, sent by Radermacher to Camper, after Camper's original sketches, as reproduced by Lucæ.

of these monsters have been captured, for an entire skeleton, very badly set up, which had been sent to the Museum of the Prince of Orange, and which I saw only on the 27th of June, 1784, was more than four feet high. I examined this skeleton again on the 19th December, 1785, after it had been excellently put to rights by the ingenious Onymus."

It appears evident, then, that this skeleton, which is doubtless that which has always gone by the name of Wurmb's Pongo, is not that of the animal described by him, though unquestionably similar in all essential points.

Camper proceeds to note some of the most important features of this skeleton; promises to describe it in detail by-and-bye; and is evidently in doubt as to the relation of this great "Pongo" to his "petit Orang."

The promised further investigations were never carried out; and so it happened that the Pongo of Von Wurmb took its place by the side of the Chimpanzee, Gibbon, and Orang as a fourth and colossal species of man-like Ape. And indeed nothing could look much less like the Chimpanzees or the Orangs, then known, than the Pongo; for all the specimens of Chimpanzee and Orang which had been observed were small of stature, singularly human in aspect, gentle and docile; while Wurmb's Pongo was a monster almost twice their size, of vast strength and fierceness, and very brutal in expression; its great projecting muzzle, armed with strong teeth, being further disfigured by the outgrowth of the cheeks into fleshy lobes.

Eventually, in accordance with the usual marauding habits of the Revolutionary armies, the "Pongo" skeleton was carried away from Holland into France, and notices of it, expressly intended to demonstrate its entire distinctness from the Orang and its affinity with the baboons, were given, in 1798, by Geoffroy St. Hilaire and Cuvier.

Even in Cuvier's "Tableau Elémentaire," and in the first edition of his great work, the "Regne Animal," the "Pongo" is classed as a species of Baboon. However, so early as 1818, it appears that Cuvier saw reason to alter this opinion, and to adopt the view suggested several years before by Blumenbach,* and after him by Tilesius, that the Bornean Pongo is simply an adult Orang. In 1824, Rudolphi demonstrated, by the condition of the dentition, more fully and completely than had been done by his predecessors, that the Orangs described up to that time were all young animals, and that the skull and teeth of the adult would probably be such as those seen in the Pongo of Wurmb. In the second edition of the "Regne Animal" (1829), Cuvier infers, from the "proportions of all the parts" and "the arrangements of the foramina and sutures of the head," that the Pongo is the adult of the Orang-Utan, "at least of a very closely allied species," and this conclusion was eventually placed beyond all doubt by Professor Owen's Memoir published in the "Zoological Transactions" for 1835, and by Temminck in his "Monographies de Mammalogie." Temminck's memoir is remarkable for the completeness of the evidence which it affords as to the modification which the form of the Orang undergoes according to age and sex. Tiedemann first published an account of the brain of the young Orang, while Sandifort, Müller and Schlegel, described the muscles and the viscera of the adult, and gave the earliest detailed and trustworthy history of

* See Blumenbach *Abbildungen Naturhistorichen Gegenstande*, No. 12, 1810; and Tilesius, *Naturhistoriche Früchte der ersten Kaiserlich-Russischen Erdumsegelung*, p. 115, 1813.

the habits of the great Indian Ape in a state of nature; and as important additions have been made by later observers, we are at this moment better acquainted with the adult of the Orang-Utan, than with that of any of the other greater man-like Apes.

It is certainly the Pongo of Wurmb;* and it is as certainly not the Pongo of Battell, seeing that the Orang-Utan is entirely confined to the great Asiatic islands of Borneo and Sumatra.

And while the progress of discovery thus cleared up the history of the Orang, it also became established that the only other man-like Apes in the eastern world were the various species of Gibbon — Apes of smaller stature, and therefore attracting less attention than the Orangs, though they are spread over a much wider range of country, and are hence more accessible to observation.

Although the geographical area inhabited by the "Pongo" and "Engeco" of Battell is so much nearer to Europe than that in which the Orang and Gibbon are found, our acquaintance with the African Apes has been of slower growth; indeed, it is only within the last few years that the truthful story of the old English adventurer has been rendered fully intelligible. It was not until 1835 that the skeleton of the adult Chimpanzee became known, by the publication of Professor Owen's above-mentioned very excellent memoir "On the Osteology of the Chimpanzee and Orang," in the Zoological Transactions — a memoir which, by the accuracy of its descriptions, the carefulness of its comparisons, and the excellence of its figures, made an epoch in the history of our knowledge of the bony framework, not only of the Chimpanzee, but of all the anthropoid Apes.

By the investigations herein detailed, it became evident that the old Chimpanzee acquired a size and aspect as different from those of the young known to Tyson, to Buffon, and to Traill, as those of the old Orang from the young Orang; and the subsequent very important researches of Messrs. Savage and Wyman, the American missionary and anatomist, have not only confirmed this conclusion, but have added many new details.†

One of the most interesting among the many valuable discoveries made by Dr. Thomas Savage is the fact, that the natives in the Gaboon country at the present day, apply to the Chimpanzee

* Speaking broadly and without prejudice to the question, whether there be more than one species of Orang.

† See "Observations on the external characters and habits of the Troglodytes niger, by Thomas N. Savage, M. D., and on its organization, by Jeffries Wyman, M. D.," *Boston Journal of Natural History*, vol. iv. 1843-4; and "External characters, habits, and osteology of Troglodytes Gorilla," by the same authors, ibid. vol. v. 1847.

a name—"Enché-eko"—which is obviously identical with the "Engeco" of Battell; a discovery which has been confirmed by all later inquirers. Battell's "lesser monster" being thus proved to be a veritable existence, of course a strong presumption arose that his "greater monster," the "Pongo," would sooner or later be discovered. And, indeed, a modern traveller, Bowdich, had, in 1819, found strong evidence, among the natives, of the existence of a second great Ape, called the "Ingena," "five feet high, and four across the shoulders," the builder of a rude house, on the outside of which it slept.

In 1847, Dr. Savage had the good fortune to make another and most important addition to our knowledge of the man-like Apes; for, being unexpectedly detained at the Gaboon river, he saw in the house of the Rev. Mr. Wilson, a missionary resident there, "a skull represented by the natives to be a monkey-like animal, remarkable for its size, ferocity, and habits." From the contour of the skull, and the information derived from several intelligent natives, "I was induced," says Dr. Savage (using the term Orang in its old general sense) "to believe that it belonged to a new species of Orang. I expressed this opinion to Mr. Wilson, with a desire for further investigation; and, if possible, to decide the point by the inspection of a specimen alive or dead." The result of the combined exertions of Messrs. Savage and Wilson was not only the obtaining of a very full account of the habits of this new creature, but a still more important service to science, the enabling the excellent American anatomist already mentioned, Professor Wyman, to describe, from ample materials, the distinctive osteological characters of the new form. This animal was called by the natives of the Gaboon "Engé-ena," a name obviously identical with the "Ingena" of Bowdich; and Dr. Savage arrived at the conviction that this last discovered of all the great Apes was the long-sought "Pongo" of Battell.

The justice of this conclusion, indeed, is beyond doubt—for not only does the "Engé-ena" agree with Battell's "greater monster" in its hollow eyes, its great stature, and its dun or iron-grey colour, but the only other man-like Ape which inhabits these latitudes—the Chimpanzee—is at once identified, by its smaller size, as the "lesser monster," and is excluded from any possibility of being the "Pongo," by the fact that it is black and not dun, to say nothing of the important circumstance already mentioned that it still retains the name of "Engeco," or "Enché-eko," by which Battell knew it.

In seeking for a specific name for the "Enge-ena," however, Dr. Savage wisely avoided the much misused "Pongo"; but finding

in the ancient Periplus of Hanno the word "Gorilla" applied to certain hairy savage people, discovered by the Carthaginian voyager in an island on the African coast, he attached the specific name "*Gorilla*" to his new ape, whence arises its present well-known appellation. But Dr. Savage, more cautious than some of his successors, by no means identifies his ape with Hanno's "wild men." He merely says that the latter were "probably one of the species of the Orang;" and I quite agree with M. Brullé, that there is no ground for identifying the modern "Gorilla" with that of the Carthaginian admiral.

Since the memoir of Savage and Wyman was published, the skeleton of the Gorilla has been investigated by Professor Owen and by the late Professor Duvernoy, of the Jardin des Plantes, the latter having further supplied a valuable account of the muscular system and of many of the other soft parts; while African missionaries and travellers have confirmed and expanded the account originally given of the habits of this great man-like Ape, which has had the singular fortune of being the first to be made known to the general world and the last to be scientifically investigated.

Two centuries and a half have passed away since Battell told his stories about the "greater" and the "lesser monsters" to Purchas, and it has taken nearly that time to arrive at the clear result that there are four distinct kinds of Anthropoids — in Eastern Asia, the Gibbons and the Orangs; in Western Africa, the Chimpanzees and the Gorilla.

The man-like Apes, the history of the discovery of which has just been detailed, have certain characters of structure and of distribution in common. Thus they all have the same number of teeth as man — possessing four incisors, two canines, four false molars, and six true molars in each jaw, or 32 teeth in all, in the adult condition; while the milk dentition consists of 20 teeth — or four incisors, two canines, and four molars in each jaw. They are what are called catarhine Apes — that is, their nostrils have a narrow partition and look downwards; and, furthermore, their arms are always longer than their legs, the difference being sometimes greater and sometimes less; so that if the four were arranged in the order of the length of their arms in proportion to that of their legs, we should have this series — Orang ($1\frac{1}{2}-1$), Gibbon ($1\frac{1}{4}-1$), Gorilla ($1\frac{1}{8}-1$), Chimpanzee ($1\frac{1}{16}-1$). In all, the fore limbs are terminated by hands, provided with longer or shorter thumbs; while the great toe of the foot, always smaller than in Man, is far more movable than in him and can be opposed, like a

thumb, to the rest of the foot. None of these apes have tails, and none of them possess the cheek-pouches common among monkeys. Finally, they are all inhabitants of the old world.

The Gibbons are the smallest, slenderest, and longest-limbed of the man-like Apes: their arms are longer in proportion to their bodies than those of any of the other man-like Apes, so that they can touch the ground when erect; their hands are longer than their feet, and they are the only Anthropoids which possess callosities like the lower monkeys. They are variously coloured. The Orangs have arms which reach to the ankles in the erect position of the animal; their thumbs and great toes are very short, and their feet are longer than their hands. They are covered with reddish brown hair, and the sides of the face, in adult males, are commonly produced into two crescentic, flexible excrescences, like fatty tumours. The Chimpanzees have arms which reach below the knees; they have large thumbs and great toes; their hands are longer than their feet; and their hair is black, while the skin of the face is pale. The Gorilla, lastly, has arms which reach to the middle of the leg, large thumbs and great toes, feet longer than the hands, a black face, and dark-grey or dun hair.

For the purpose which I have at present in view, it is unnecessary that I should enter into any further minutiæ respecting the distinctive characters of the genera and species into which these man-like Apes are divided by naturalists. Suffice it to say, that the Orangs and the Gibbons constitute the distinct genera, *Simia* and *Hylobates;* while the Chimpanzees and Gorillas are by some regarded simply as distinct species of one genus, *Troglodytes;* by others as distinct genera — *Troglodytes* being reserved for the Chimpanzees, and *Gorilla* for the Engé-ena or Pongo.

Sound knowledge respecting the habits and mode of life of the man-like Apes has been even more difficult of attainment than correct information regarding their structure.

Once in a generation, a Wallace may be found physically, mentally, and morally qualified to wander unscathed through the tropical wilds of America and of Asia; to form magnificent collections as he wanders; and withal to think out sagaciously the conclusions suggested by his collections: but, to the ordinary explorer or collector, the dense forests of equatorial Asia and Africa, which constitute the favourite habitation of the Orang, the Chimpanzee, and the Gorilla, presents difficulties of no ordinary magnitude; and the man who risks his life by even a short visit to the malarious shores of those regions may well be excused if he shrinks from facing the dangers of the interior; if he contents himself with

stimulating the industry of the better seasoned natives, and collecting and collating the more or less mythical reports and traditions with which they are too ready to supply him.

In such a manner most of the earlier accounts of the habits of the man-like Apes originated; and even now a good deal of what passes current must be admitted to have no very safe foundation. The best information we possess is that, based almost wholly on direct European testimony, respecting the Gibbons; the next best evidence relates to the Orangs; while our knowledge of the habits of the Chimpanzee and the Gorilla stands much in need of support and enlargement by additional testimony from instructed European eye-witnesses.

It will therefore be convenient in endeavouring to form a notion of what we are justified in believing about these animals, to commence with the best known man-like Apes, the Gibbons and Orangs; and to make use of the perfectly trustworthy information respecting them as a sort of criterion of the probable truth or falsehood of assertions respecting the others.

Of the GIBBONS, half a dozen species are found scattered over the Asiatic islands, Java, Sumatra, Borneo, and through Malacca, Siam, Arracan, and an uncertain extent of Hindostan, on the main land of Asia. The largest attain a few inches above three feet in height, from the crown to the heel, so that they are shorter than the other man-like Apes; while the slenderness of their bodies renders their mass far smaller in proportion even to this diminished height.

Dr. Salomon Müller, an accomplished Dutch naturalist, who lived for many years in the Eastern Archipelago, and to the results of whose personal experience I shall frequently have occasion to refer, states that the Gibbons are true mountaineers, loving the slopes and edges of the hills, though they rarely ascend beyond the limit of the fig-trees. All day long they haunt the tops of the tall trees; and though, towards evening, they descend in small troops to the open ground, no sooner do they spy a man than they dart up the hill-sides, and disappear in the darker valleys.

All observers testify to the prodigious volume of voice possessed by these animals. According to the writer whom I have just cited, in one of them, the Siamang, "the voice is grave and penetrating, resembling the sounds gōek, gōek, gōek, goek, goek ha ha ha ha haaāāā, and may easily be heard at a distance of half a league." While the cry is being uttered, the great membranous bag under the throat which communicates with the organ of voice, the so-called "laryngeal sac," becomes greatly distended, diminishing again when the creature relapses into silence.

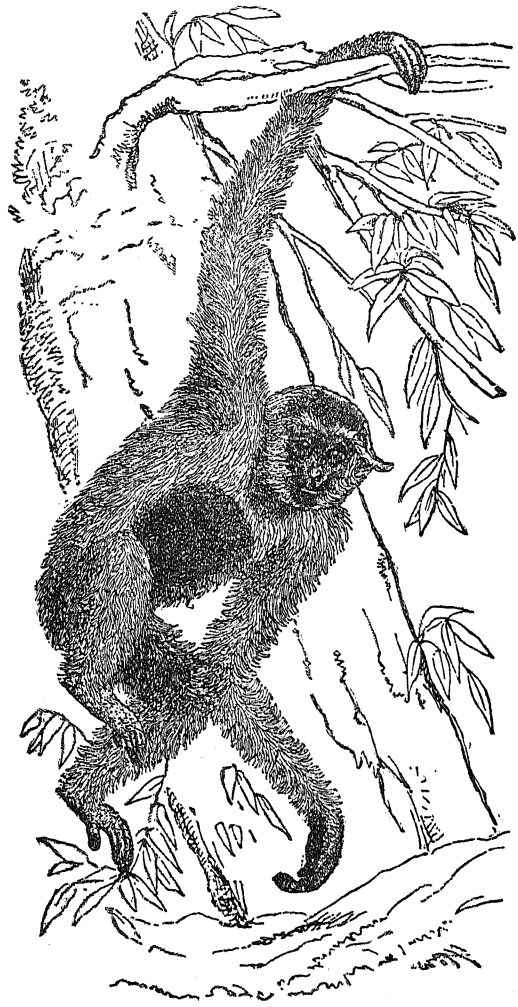


Fig. 8.—A Gibbon (*H. pileatus*), after Wolf.

M. Duvaucel, likewise, affirms that the cry of the Siamang may be heard for miles — making the woods ring again. So Mr. Martin * describes the cry of the agile Gibbon as "overpowering and

* *Man and Monkies*, p. 423.

deafening" in a room, and "from its strength, well calculated for resounding through the vast forests." Mr. Waterhouse, an accomplished musician as well as zoologist, says, "The Gibbon's voice is certainly much more powerful than that of any singer I ever heard." And yet it is to be recollected that this animal is not half the height of, and far less bulky in proportion than, a man.

There is good testimony that various species of Gibbon readily take to the erect posture. Mr. George Bennett,* a very excellent observer, in describing the habits of a male *Hylobates syndactylus* which remained for some time in his possession, says: "He invariably walks in the erect posture when on a level surface; and then the arms either hang down, enabling him to assist himself with his knuckles; or what is more usual, he keeps his arms uplifted in nearly an erect position, with the hands pendent ready to seize a rope, and climb up on the approach of danger or on the obtrusion of strangers. He walks rather quick in the erect posture, but with a waddling gait, and is soon run down if, whilst pursued, he has no opportunity of escaping by climbing. . . . When he walks in the erect posture he turns the leg and foot outwards, which occasions him to have a waddling gait and to seem bow-legged."

Dr. Burrough states of another Gibbon, the Horlack or Hooluk:

"They walk erect; and when placed on the floor, or in an open field, balance themselves very prettily, by raising their hands over their head and slightly bending the arm at the wrist and elbow, and then run tolerably fast, rocking from side to side; and, if urged to greater speed, they let fall their hands to the ground, and assist themselves forward, rather jumping than running, still keeping the body, however, nearly erect."

Somewhat different evidence, however, is given by Dr. Winslow Lewis:†

"Their only manner of walking was on their posterior or inferior extremities, the others being raised upwards to preserve their equilibrium, as rope-dancers are assisted by long poles at fairs. Their progression was not by placing one foot before the other, but by simultaneously using both, as in jumping." Dr. Salomon Müller also states that the Gibbons progress along the ground by short series of tottering jumps, effected only by the hind limbs, the body being held altogether upright.

But Mr. Martin (*l. c.* p. 418), who also speaks from direct observation, says of the Gibbons generally:

* *Wanderings in New South Wales*, vol. ii. chap. viii. 1834.
† *Boston Journal of Natural History*, vol. i. 1834.

"Pre-eminently qualified for arboreal habits and displaying among the branches amazing activity, the Gibbons are not so awkward or embarrassed on a level surface as might be imagined. They walk erect, with a waddling or unsteady gait, but at a quick pace; the equilibrium of the body requiring to be kept up, either by touching the ground with the knuckles, first on one side then on the other, or by uplifting the arms so as to poise it. As with the Chimpanzee, the whole of the narrow, long sole of the foot is placed upon the ground at once and raised at once, without any elasticity of step."

After this mass of concurrent and independent testimony, it cannot reasonably be doubted that the Gibbons commonly and habitually assume the erect attitude.

But level ground is not the place where these animals can display their very remarkable and peculiar locomotive powers, and that prodigious activity which almost tempts one to rank them among flying, rather than among ordinary climbing mammals.

Mr. Martin (*l. c.* p. 430) has given so excellent and graphic an account of the movements of a *Hylobates agilis,* living in the Zoological Gardens, in 1840, that I will quote it in full:

"It is almost impossible to convey in words an idea of the quickness and graceful address of her movements: they may indeed be termed aerial, as she seems merely to touch in her progress the branches among which she exhibits her evolutions. In these feats her hands and arms are the sole organs of locomotion; her body hanging as if suspended by a rope, sustained by one hand (the right for example), she launches herself, by an energetic movement, to a distant branch, which she catches with the left hand; but her hold is less than momentary: the impulse for the next launch is acquired: the branch then aimed at is attained by the right hand again and quitted instantaneously, and so on in alternate succession. In this manner spaces of twelve and eighteen feet are cleared, with the greatest ease and uninterruptedly, for hours together, without the slightest appearance of fatigue being manifested; and it is evident that if more space could be allowed, distances very greatly exceeding eighteen feet would be as easily cleared; so that Duvaucel's assertion that he had seen these animals launch themselves from one branch to another, forty feet asunder, startling as it is, may be well credited. Sometimes, on seizing a branch in her progress, she will throw herself, by the power of one arm only, completely round it, making a revolution with such rapidity as almost to deceive the eye, and continue her progress with undiminished velocity. It is singular to observe how suddenly this Gibbon can stop, when the impetus given by the rapidity and distance of her swinging leaps would seem to require a gradual abatement of her movements. In the very midst of her flight a branch is seized, the body raised, and she is seen, as if by magic, quietly seated on it, grasping it with her feet. As suddenly she again throws herself into action.

"The following facts will convey some notion of her dexterity and

quickness. A live bird was let loose in her apartment; she marked its flight, made a long swing to a distant branch, caught the bird with one hand in her passage, and attained the branch with her other hand; her aim, both at the bird and at the branch, being as successful as if one object only had engaged her attention. It may be added that she instantly bit off the head of the bird, picked its feathers, and then threw it down without attempting to eat it.

"On another occasion this animal swung herself from a perch, across a passage at least twelve feet wide, against a window which it was thought would be immediately broken: but not so; to the surprise of all, she caught the narrow framework between the panes with her hand, in an instant attained the proper impetus, and sprang back again to the cage she had left — a feat requiring not only great strength, but the nicest precision."

The Gibbons appear to be naturally very gentle, but there is very good evidence that they will bite severely when irritated — a female *Hylobates agilis* having so severely lacerated one man with her long canines, that he died; while she had injured others so much that, by way of precaution, these formidable teeth had been filed down; but, if threatened, she would still turn on her keeper. The Gibbons eat insects, but appear generally to avoid animal food. A Siamang, however, was seen by Mr. Bennett to seize and devour greedily a live lizard. They commonly drink by dipping their fingers in the liquid and then licking them. It is asserted that they sleep in a sitting posture.

Duvaucel affirms that he has seen the females carry their young to the waterside and there wash their faces, in spite of resistance and cries. They are gentle and affectionate in captivity — full of tricks and pettishness, like spoiled children, and yet not devoid of a certain conscience, as an anecdote, told by Mr Bennett (*l. c.* p. 156), will show. It would appear that his Gibbon had a peculiar inclination for disarranging things in the cabin. Among these articles, a piece of soap would especially attract his notice, and for the removal of this he had been once or twice scolded. "One morning," says Mr. Bennett, "I was writing, the ape being present in the cabin, when casting my eyes towards him, I saw the little fellow taking the soap. I watched him without his perceiving that I did so: and he occasionally would cast a furtive glance towards the place where I sat. I pretended to write; he, seeing me busily occupied, took the soap, and moved away with it in his paw. When he had walked half the length of the cabin, I spoke quietly, without frightening him. The instant he found I saw him, he walked back again, and deposited the soap nearly in the same place from whence he had taken it. There was certainly something more than instinct in that action; he evidently betrayed a con-



Fig. 9.—An adult male Orang-Utan, after Müller and Schlegel.

sciousness of having done wrong both by his first and last actions — and what is reason if that is not an exercise of it?"

The most elaborate account of the natural history of the ORANG-UTAN extant, is that given in the "Verhandelingen over de Natuurlijke Geschiedenis der Nederlandsche overzeesche Bezittingen (1839-'45)," by Dr. Salomon Müller and Dr. Schlegel, and I shall base what I have to say upon this subject almost entirely on their

statements, adding, here and there, particulars of interest from the writings of Brooke, Wallace, and others.

The Orang-Utan would rarely seem to exceed four feet in height, but the body is very bulky, measuring two-thirds of the height in circumference.*

The Orang-Utan is found only in Sumatra and Borneo, and is common in neither of these islands — in both of which it occurs always in low, flat plains, never in the mountains. It loves the densest and most sombre of the forests, which extend from the sea-shore inland, and thus is found only in the eastern half of Sumatra, where alone such forests occur, though, occasionally, it strays over to the western side.

On the other hand, it is generally distributed through Borneo, except in the mountains, or where the population is dense. In favourable places, the hunter may, by good fortune, see three or four in a day.

Except in the pairing time, the old males usually live by themselves. The old females, and the immature males, on the other hand, are often met with in twos and threes; and the former occasionally have young with them, though the pregnant females usually separate themselves, and sometimes remain apart after they have given birth to their offspring. The young Orangs seem to remain unusually long under their mother's protection, probably in consequence of their slow growth. While climbing, the mother always carries her young against her bosom, the young holding on by his mother's hair.† At what time of life the Orang-Utan becomes capable of propagation, and how long the females go with young, is unknown, but it is probable that they are not adult until

* The largest Orang-Utan, cited by Temminck, measured, when standing upright, four feet; but he mentions having just received news of the capture of an Orang five feet three inches high. Schlegel and Müller say that their largest old male measured, upright, 1.25 Netherlands "el"; and from the crown to the end of the toes, 1.5 el; the circumference of the body being about 1 el. The largest old female was 1.09 el high, when standing. The adult skeleton in the College of Surgeons' Museum, if set upright, would stand 3 ft. 6-8 in. from crown to sole. Dr. Humphry gives 3 ft. 8 in. as the mean height of two Orangs. Of seventeen Orangs examined by Mr. Wallace, the largest was 4 ft. 2 in. high, from the heel to the crown of the head. Mr. Spencer St. John, however, in his *Life in the Forests of the Far East*, tells us of an Orang of "5 ft. 2 in., measuring fairly from the head to the heel," 15 in. across the face, and 12 in. round the wrist. It does not appear, however, that Mr. St. John measured this Orang himself.

† See Mr. Wallace's account of an infant "Orang-utan," in the *Annals of Natural History* for 1856. Mr. Wallace provided his interesting charge with an artificial mother of buffalo-skin, but the cheat was too successful. The infant's entire experience led it to associate teats with hair, and feeling the latter, it spent its existence in vain endeavors to discover the former.

they arrive at ten or fifteen years of age. A female which lived for five years at Batavia had not attained one-third the height of the wild females. It is probable that, after reaching adult years, they go on growing, though slowly, and that they live to forty or fifty years. The Dyaks tell of old Orangs, which have not only lost all their teeth, but which find it so troublesome to climb, that they maintain themselves on windfalls and juicy herbage.

The Orang is sluggish, exhibiting none of that marvellous activity characteristic of the Gibbons. Hunger alone seems to stir him to exertion, and when it is stilled, he relapses into repose. When the animal sits, it curves its back and bows its head, so as to look straight down on the ground; sometimes it holds on with its hands by a higher branch, sometimes lets them hang phlegmatically down by its side—and in these positions the Orang will remain, for hours together, in the same spot, almost without stirring, and only now and then giving utterance to his deep, growling voice. By day he usually climbs from one tree-top to another, and only at night descends to the ground, and if then threatened with danger, he seeks refuge among the underwood. When not hunted, he remains a long time in the same locality, and sometimes stops for many days on the same tree—a firm place among its branches serving him for a bed. It is rare for the Orang to pass the night in the summit of a large tree, probably because it is too windy and cold there for him; but, as soon as night draws on, he descends from the height and seeks out a fit bed in the lower and darker part, or in the leafy top of a small tree, among which he prefers Nibong Palms, Pandani, or one of those parasitic Orchids which give the primæval forests of Borneo so characteristic and striking an appearance. But wherever he determines to sleep, there he prepares himself a sort of nest: little boughs and leaves are drawn together round the selected spot, and bent crosswise over one another; while to make the bed soft, great leaves of Ferns, of Orchids, of *Pandanus fascicularis, Nipa fruticans,* &c., are laid over them. Those which Müller saw, many of them being very fresh, were situated at a height of ten to twenty-five feet above the ground, and had a circumference, on the average, of two or three feet. Some were packed many inches thick with *Pandanus* leaves; others were remarkable only for the cracked twigs, which united in a common centre, formed a regular platform. "The rude *hut*," says Sir James Brooke, "which they are stated to build in the trees, would be more properly called a seat or nest, for it has no roof or cover of any sort. The facility with which they form this nest is curious, and I had an opportunity of

seeing a wounded female weave the branches together and seat herself, within a minute."

According to the Dyaks the Orang rarely leaves his bed before the sun is well above the horizon and has dissipated the mists. He gets up about nine, and goes to bed again about five; but sometimes not till late in the twilight. He lies sometimes on his back; or, by way of change, turns on one side or the other, drawing his limbs up to his body, and resting his head on his hand. When the night is cold, windy, or rainy, he usually covers his body with a heap of *Pandanus, Nipa,* or Fern leaves, like those of which his bed is made, and he is especially careful to wrap up his head in them. It is this habit of covering himself up which has probably led to the fable that the Orang builds huts in the trees.

Although the Orang resides mostly amid the boughs of great trees, during the daytime, he is very rarely seen squatting on a thick branch, as other apes, and particularly the Gibbons, do. The Orang, on the contrary, confines himself to the slender leafy branches, so that he is seen right at the top of the trees, a mode of life which is closely related to the constitution of his hinder limbs, and especially to that of his seat. For this is provided with no callosities, such as are possessed by many of the lower apes, and even by the Gibbons; and those bones of the pelvis, which are termed the ischia, and which form the solid framework of the surface on which the body rests in the sitting posture, are not expanded like those of the apes which possess callosities, but are more like those of man.

An Orang climbs so slowly and cautiously,* as, in this act, to resemble a man more than an ape, taking great care of his feet, so that injury of them seems to affect him far more than it does other apes. Unlike the Gibbons, whose forearms do the greater part of the work, as they swing from branch to branch, the Orang never makes even the smallest jump. In climbing, he moves alternately one hand and one foot, or, after having laid fast hold with the hands, he draws up both feet together. In passing from one tree to another, he always seeks out a place where the twigs of both come close together, or interlace. Even when closely pursued, his circumspection is amazing: he shakes the branches to see if they will bear him, and then bending an overhanging bough down by throwing his weight gradually along it, he makes a bridge from the tree he wishes to quit to the next.†

* "They are the slowest and least active of all the monkey tribe, and their motions are surprisingly awkward and uncouth."—Sir James Brooke, in the *Proceedings of the Zoological Society*, 1841.

† Mr. Wallace's account of the progression of the Orang almost exactly corresponds with this.

On the ground the Orang always goes laboriously and shakily, on all fours. At starting he will run faster than a man, though he may soon be overtaken. The very long arms which, when he runs, are but little bent, raise the body of the Orang remarkably, so that he assumes much the posture of a very old man bent down by age, and making his way along by the help of a stick. In walking, the body is usually directed straight forward, unlike the other apes, which run more or less obliquely; except the Gibbons, who in these as in so many other respects, depart remarkably from their fellows.

The Orang cannot put its feet flat on the ground, but is supported upon their outer edges, the heel resting more on the ground, while the curved toes partly rest upon the ground by the upper side of their first joint, the two outermost toes of each foot completely resting on this surface. The hands are held in the opposite manner, their inner edges serving as the chief support. The fingers are then bent out in such a manner that their foremost joints, especially those of the two innermost fingers, rest upon the ground by their upper sides, while the point of the free and straight thumb serves as an additional fulcrum.

The Orang never stands on its hind legs, and all the pictures, representing it as so doing, are as false as the assertion that it defends itself with sticks, and the like.

The long arms are of especial use, not only in climbing, but in the gathering of food from boughs to which the animal could not trust his weight. Figs, blossoms, and young leaves of various kinds, constitute the chief nutriment of the Orang; but strips of bamboo two or three feet long were found in the stomach of a male. They are not known to eat living animals.

Although, when taken young, the Orang-Utan soon becomes domesticated, and indeed seems to court human society, it is naturally a very wild and shy animal, though apparently sluggish and melancholy. The Dyaks affirm, that when the old males are wounded with arrows only, they will occasionally leave the trees and rush raging upon their enemies, whose sole safety lies in instant flight, as they are sure to be killed if caught.*

* Sir James Brooke, in a letter to Mr. Waterhouse, published in the proceedings of the Zoological Society for 1841, says:—"On the habits of the Orangs, as far as I have been able to observe them, I may remark that they are as dull and slothful as can well be conceived, and on no occasion, when pursuing them, did they move so fast as to preclude my keeping pace with them easily through a moderately clear forest; and even when obstructions below (such as wading up to the neck) allowed them to get away some distance, they were sure to stop and allow me to come up. I never observed the slightest attempt at defence, and the wood which sometimes rattled about our ears was broken by their weight, and not thrown, as some persons represent. If pushed

But, though possessed of immense strength, it is rare for the Orang to attempt to defend itself, especially when attacked with fire-arms. On such occasions he endeavours to hide himself, or to escape along the topmost branches of the trees, breaking off and throwing down the boughs as he goes. When wounded he betakes himself to the highest attainable point of the tree, and emits a singular cry, consisting at first of high notes, which at length deepen into a low roar, not unlike that of a panther. While giving out the high notes the Orang thrusts out his lips into a funnel shape; but in uttering the low notes he holds his mouth wide open, and at the same time the great throat bag, or laryngeal sac, becomes distended.

According to the Dyaks, the only animal the Orang measures his strength with is the crocodile, who occasionally seizes him on his visits to the water side. But they say that the Orang is more than a match for his enemy, and beats him to death, or rips up his throat by pulling the jaws asunder!

Much of what has been here stated was probably derived by Dr. Müller from the reports of his Dyak hunters; but a large male, four feet high, lived in captivity, under his observation, for a month, and receives a very bad character.

"He was a very wild beast," says Müller, "of prodigious strength and false and wicked to the last degree. If any one approached he rose up slowly with a low growl, fixed his eyes in the direction in which he meant to make his attack, slowly passed his hand between the bars of his cage, and then extending his long arm, gave a sudden grip — usually at the face." He never tried to bite (though Orangs will bite one another), his great weapons of offence and defence being his hands.

His intelligence was very great; and Müller remarks that though the faculties of the Orang have been estimated too highly,

to extremity, however, the *Pappan* could not be otherwise than formidable, and one unfortunate man, who, with a party, was trying to catch a large one alive, lost two of his fingers, besides being severely bitten on the face, whilst the animal finally beat off his pursuers and escaped."

Mr. Wallace, on the other hand, affirms that he has several times observed them throwing down branches when pursued. "It is true he does not throw them *at* a person, but casts them down vertically; for it is evident that a bough cannot be thrown to any distance from the top of a lofty tree. In one case a female Mias, on a durian tree, kept up for at least ten minutes a continuous shower of branches and of the heavy, spined fruits, as large as 32-pounders, which most effectually kept us clear of the tree she was on. She could be seen breaking them off and throwing them down with every appearance of rage, uttering at intervals a loud pumping grunt, and evidently meaning mischief."— "On the Habits of the Orang-Utan," *Annals of Natural History*, 1856. This statement, it will be observed, is quite in accordance with that contained in the letter of the Resident Palm quoted above.

yet Cuvier, had he seen this specimen, would not have considered its intelligence to be only a little higher than that of the dog.

His hearing was very acute, but the sense of vision seemed to be less perfect. The under lip was the great organ of touch, and played a very important part in drinking, being thrust out like a trough, so as either to catch the falling rain, or to receive the contents of the half cocoa-nut shell full of water with which the Orang was supplied, and which, in drinking, he poured into the trough thus formed.

In Borneo the Orang-Utan of the Malays goes by the name of "*Mias*" among the Dyaks, who distinguish several kinds as *Mias Pappan,* or *Zimo, Mias Kassu,* and *Mias Rambi.* Whether these are distinct species, however, or whether they are mere races, and how far any of them are identical with the Sumatran Orang, as Mr. Wallace thinks the Mias Pappan to be, are problems which are at present undecided; and the variability of these great apes is so extensive, that the settlement of the question is a matter of great difficulty. Of the form called "Mias Pappan," Mr. Wallace * observes,

"It is known by its large size, and by the lateral expansion of the face into fatty protuberances, or ridges, over the temporal muscles, which have been mis-termed *callosities*, as they are perfectly soft, smooth, and flexible. Five of this form, measured by me, varied only from 4 feet 1 inch to 4 feet 2 inches in height, from the heel to the crown of the head, the girth of the body from 3 feet to 3 feet 7½ inches, and the extent of the outstretched arms from 7 feet 2 inches to 7 feet 6 inches; the width of the face from 10 to 13¼ inches. The colour and length of the hair varied in different individuals, and in different parts of the same individual; some possessed a rudimentary nail on the great toe, others none at all; but they otherwise present no external differences on which to establish even varieties of a species.

"Yet, when we examine the crania of these individuals, we find remarkable differences of form, proportion, and dimension, no two being exactly alike. The slope of the profile, and the projection of the muzzle, together with the size of the cranium, offer differences as decided as those existing between the most strongly marked forms of the Caucasian and African crania in the human species. The orbits vary in width and height, the cranial ridge is either single or double, either much or little developed, and the zygomatic aperture varies considerably in size. This variation in the proportions of the crania enables us satisfactorily to explain the marked difference presented by the single-crested and double-crested skulls, which have been thought to prove the existence of two large species of Orang. The external surface of the skull varies considerably in size, as do also the zygomatic aperture and the temporal

* On the Orang-Utan, or Mias of Borneo, *Annals of Natural History,* 1856.

muscle; but they bear no necessary relation to each other, a small muscle often existing with a large cranial surface, and *vice versâ*. Now, those skulls which have the largest and strongest jaws and the widest zygomatic aperture, have the muscles so large that they meet on the crown of the skull, and deposit the bony ridge which separates them, and which is the highest in that which has the smallest cranial surface. In those which combine a large surface with comparatively weak jaws, and small zygomatic aperture, the muscles, on each side, do not extend to the crown, a space of from 1 to 2 inches remaining between them, and along their margins small ridges are formed. Intermediate forms are found, in which the ridges meet only in the hinder part of the skull. The form and size of the ridges are therefore independent of age, being sometimes more strongly developed in the less aged animal. Professor Temminck states that the series of skulls in the Leyden Museum shows the same result."

Mr. Wallace observed two male adult Orangs (Mias Kassu of the Dyaks), however, so very different from any of these that he concludes them to be specifically distinct; they were respectively 3 feet 8½ inches and 3 feet 9½ inches high, and possessed no sign of the cheek excrescences, but otherwise resembled the larger kinds. The skull has no crest, but two bony ridges, 1¾ inches to 2 inches apart, as in the *Simia morio* of Professor Owen. The teeth, however, are immense, equalling or surpassing those of the other species. The females of both these kinds, according to Mr. Wallace, are devoid of excrescences, and resemble the smaller males, but are shorter by 1½ to 3 inches, and their canine teeth are comparatively small, subtruncated and dilated at the base, as in the so-called *Simia morio*, which is, in all probability, the skull of a female of the same species as the smaller males. Both males and females of this smaller species are distinguishable, according to Mr. Wallace, by the comparatively large size of the middle incisors of the upper jaw.

So far as I am aware, no one has attempted to dispute the accuracy of the statements which I have just quoted regarding the habits of the two Asiatic man-like apes; and if true, they must be admitted as evidence, that such an Ape—

1stly, May readily move along the ground in the erect, or semi-erect, position, and without direct support from its arms.

2ndly, That it may possess an extremely loud voice, so loud as to be readily heard one or two miles.

3rdly, That it may be capable of great viciousness and violence when irritated: and this is especially true of adult males.

4thly, That it may build a nest to sleep in.

Such being well established facts respecting the Asiatic An-

thropoids, analogy alone might justify us in expecting the African species to offer similar peculiarities, separately or combined; or, at any rate, would destroy the force of any attempted *a priori* argument against such direct testimony as might be adduced in favour of their existence. And, if the organization of any of the African Apes could be demonstrated to fit it better than either of its Asiatic allies for the erect position and for efficient attack, there would be still less reason for doubting its occasional adoption of the upright attitude or of aggressive proceedings.

From the time of Tyson and Tulpius downwards, the habits of the young CHIMPANZEE in a state of captivity have been abundantly reported and commented upon. But trustworthy evidence as to the manners and customs of adult anthropoids of this species, in their native woods, was almost wanting up to the time of the publication of the paper by Dr. Savage, to which I already referred; containing notes of the observations which he made, and of the information which he collected from sources which he considered trustworthy, while resident at Cape Palmas, at the north-western limit of the Bight of Benin.

The adult Chimpanzees measured by Dr. Savage, never exceeded, though the males may almost attain, five feet in height.

"When at rest the sitting posture is that generally assumed. They are sometimes seen standing and walking, but when thus detected, they immediately take to all fours, and flee from the presence of the observer. Such is their organisation that they cannot stand erect, but lean forward. Hence they are seen, when standing, with the hands clasped over the occiput, or the lumbar region, which would seem necessary to balance or ease of posture.

"The toes of the adult are strongly flexed and turned inwards, and cannot be perfectly straightened. In the attempt the skin gathers into thick folds on the back, showing that the full expansion of the foot, as is necessary in walking, is unnatural. The natural position is on all fours, the body anteriorly resting upon the knuckles. These are greatly enlarged, with the skin protuberant and thickened like the sole of the foot.

"They are expert climbers, as one would suppose from their organisation. In their gambols they swing from limb to limb to a great distance, and leap with astonishing agility. It is not unusual to see the 'old folks' (in the language of an observer) sitting under a tree regaling themselves with fruit and friendly chat, while their 'children' are leaping around them, and swinging from tree to tree with boisterous merriment.

"As seen here, they cannot be called *gregarious*, seldom more than five, or ten at most, being found together. It has been said, on good authority, that they occasionally assemble in large numbers, in gambols. My informant asserts that he saw once not less than fifty so engaged; hooting, screaming, and drumming with sticks upon old logs, which is done in the latter case with equal facility by the four extremities. They do

not appear ever to act on the offensive, and seldom, if ever really, on the defensive. When about to be captured, they resist by throwing their arms about their opponent, and attempting to draw him into contact with their teeth." (Savage, *l. c.* p. 384.)

With respect to this last point Dr. Savage is very explicit in another place:

"*Biting* is their principal art of defence. I have seen one man who had been thus severely wounded in the feet.

"The strong development of the canine teeth in the adult would seem to indicate a carnivorous propensity; but in no state save that of domestication do they manifest it. At first they reject flesh, but easily acquire a fondness for it. The canines are early developed, and evidently designed to act the important part of weapons of defence. When in contact with man almost the first effort of the animal is — *to bite.*

"They avoid the abodes of men, and build their habitations in trees. Their construction is more that of *nests* than *huts*, as they have been erroneously termed by some naturalists. They generally build not far above the ground. Branches or twigs are bent, or partly broken, and crossed, and the whole supported by the body of a limb or a crotch. Sometimes a nest will be found near the *end* of a *strong leafy branch* twenty or thirty feet from the ground. One I have lately seen that could not be less than forty feet, and more probably it was fifty. But this is an unusual height.

"Their dwelling-place is not permanent, but changed in pursuit of food and solitude, according to the force of circumstances. We more often see them in elevated places; but this arises from the fact that the low grounds, being more favourable for the natives' rice-farms, are the oftener cleared, and hence are almost always wanting in suitable trees for their nests. . . . It is seldom that more than one or two nests are seen upon the same tree, or in the same neighbourhood: five have been found, but it was an unusual circumstance." . . .

"They are very filthy in their habits. . . . It is a tradition with the natives generally here, that they were once members of their own tribe: that for their depraved habits they were expelled from all human society, and, that through an obstinate indulgence of their vile propensities, they have degenerated into their present state and organisation. They are, however, eaten by them, and when cooked with the oil and pulp of the palm-nut considered a highly palatable morsel.

"They exhibit a remarkable degree of intelligence in their habits, and, on the part of the mother, much affection for their young. The second female described was upon a tree when first discovered, with her mate and two young ones (a male and a female). Her first impulse was to descend with great rapidity and make off into the thicket, with her mate and female offspring. The young male remaining behind, she soon returned to the rescue. She ascended and took him in her arms, at which moment she was shot, the ball passing through the fore-arm of the young one, on its way to the heart of the mother. . . .

"In a recent case, the mother, when discovered, remained upon the tree with her offspring, watching intently the movements of the hunter. As he took aim, she motioned with her hand, precisely in the manner of a human being, to have him desist and go away. When the wound has not proved instantly fatal, they have been known to stop the flow of blood by pressing with the hand upon the part, and when this did not succeed, to apply leaves and grass. . . . When shot, they give a sudden screech, not unlike that of a human being in sudden and acute distress."

The ordinary voice of the Chimpanzee, however, is affirmed to be hoarse, guttural, and not very loud, somewhat like "whoo-whoo." (*l. c.* p. 365.)

The analogy of the Chimpanzee to the Orang, in its nest-building habit and in the mode of forming its nest, is exceedingly interesting; while, on the other hand, the activity of this ape, and its tendency to bite, are particulars in which it rather resembles the Gibbons. In extent of geographical range, again, the Chimpanzees — which are found from Sierra Leone to Congo — remind one of the Gibbons, rather than of either of the other man-like apes; and it seems not unlikely that, as is the case with the Gibbons, there may be several species spread over the geographical area of the genus.

The same excellent observer, from whom I have borrowed the preceding account of the habits of the adult Chimpanzee, published fifteen years ago,* an account of the GORILLA, which has, in its most essential points, been confirmed by subsequent observers, and to which so very little has really been added, that in justice to Dr. Savage I give it almost in full.

"It should be borne in mind that my account is based upon the statements of the aborigines of that region (the Gaboon). In this connection, it may also be proper for me to remark, that having been a missionary resident for several years, studying, from habitual intercourse, the African mind and character, I felt myself prepared to discriminate and decide upon the probability of their statements. Besides, being familiar with the history and habits of its interesting congener (*Trog. niger*, Geoff.), I was able to separate their accounts of the two animals which, having the same locality and a similarity of habit, are confounded in the minds of the mass, especially as but few — such as traders to the interior and huntsmen — have ever seen the animal in question.

"The tribe from which our knowledge of the animal is derived, and whose territory forms its habitat, is the *Mpongwe*, occupying both banks of the River Gaboon, from its mouth to some fifty or sixty miles upward. . . .

* Notice of the external characters and habits of Troglodytes Gorilla. *Boston Journal of Natural History.*

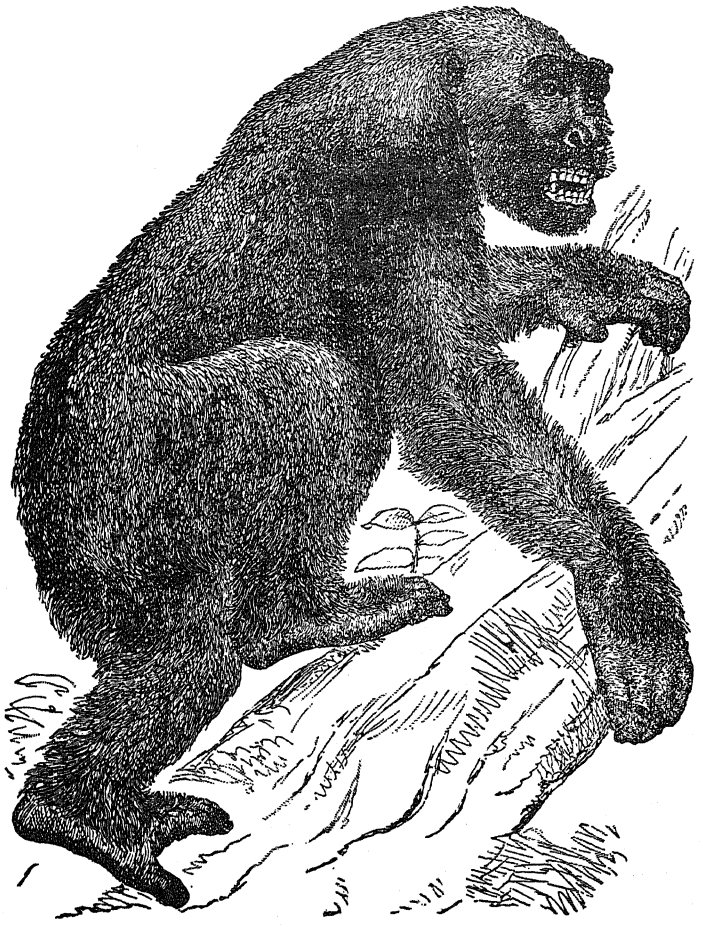


Fig. 10.—The Gorilla, after Wolf.

"If the word 'Pongo' be of African origin, it is probably a corruption of the word *Mpongwe*, the name of the tribe on the banks of the Gaboon, and hence applied to the region they inhabit. Their local name for the Chimpanzee is *Enché-eko*, as near as it can be Anglicised, from which the common term 'Jocko' probably comes. The Mpongwe appellation for its new congener is *Engé-ena*, prolonging the sound of the first vowel, and slightly sounding the second.

"The habitat of the *Engé-ena* is the interior of lower Guinea, whilst that of the *Enché-eko*, is nearer the seaboard.

"Its height is about five feet; it is disproportionately broad across the shoulders, thickly covered with coarse black hair, which is said to be similar in its arrangement to that of the *Enché-eko;* with age it becomes gray, which fact has given rise to the report that both animals are seen of different colours.

"*Head.*— The prominent features of the head are, the great width and elongation of the face, the depth of the molar region, the branches of the lower jaw being very deep and extending far backward, and the comparative smallness of the cranial portion; the eyes are very large, and said to be like those of the Enché-eko, a bright hazel; nose broad and flat, slightly elevated towards the root; the muzzle broad, and prominent lips and chin, with scattered gray hairs; the under lip highly mobile, and capable of great elongation when the animal is enraged, then hanging over the chin; skin of the face and ears naked, and of a dark brown, approaching to black.

"The most remarkable feature of the head is a high ridge, or crest of hair, in the course of the sagittal suture, which meets posteriorly with



Fig. 11.— Gorilla walking (after Wolf).

a transverse ridge of the same, but less prominent, running round from the back of one ear to the other. The animal has the power of moving the scalp freely forward and back, and when enraged is said to contract it strongly over the brow, thus bringing down the hairy ridge and pointing the hair forward, so as to present an indescribably ferocious aspect.

"Neck short, thick, and hairy; chest and shoulders very broad, said to be fully double the size of the Enché-ekos; arms very long, reaching some way below the knee — the fore-arm much the shortest; hands very large, the thumbs much larger than the fingers. . . .

"The gait is shuffling; the motion of the body, which is never upright as in man, but bent forward, is somewhat rolling, or from side to side. The arms being longer than the Chimpanzee, it does not stoop as much in walking; like that animal, it makes progression by thrusting its arms forward, resting the hands on the ground, and then giving the body a half jumping, half swinging motion between them. In this act it is said

but to extend them, making a fulcrum of the hand. When it assumes the walking posture, to which it is said to be much inclined, it balances its huge body by flexing its arms upward.

"They live in bands, but are not so numerous as the Chimpanzees; the females generally exceed the other sex in number. My informants all agree in the assertion that but one adult male is seen in a band; that when the young males grow up, a contest takes place for mastery, and the strongest, by killing and driving out the others, establishes himself as the head of the community."

Dr. Savage repudiates the stories about the Gorillas carrying off women and vanquishing elephants and then adds—

"Their dwellings, if they may be so called, are similar to those of the Chimpanzee, consisting simply of a few sticks and leafy branches. supported by the crotches and limbs of trees: they afford no shelter, and are occupied only at night.

"They are exceedingly ferocious, and always offensive in their habits, never running from man, as does the Chimpanzee. They are objects of terror to the natives, and are never encountered by them except on the defensive. The few that have been captured were killed by elephant hunters and native traders, as they came suddenly upon them while passing through the forests.

"It is said that when the male is first seen he gives a terrific yell, that resounds far and wide through the forest, something like kh — ah! kh — ah! prolonged and shrill. His enormous jaws are widely opened at each expiration, his under lip hangs over the chin, and the hairy ridge and scalp are contracted upon the brow, presenting an aspect of indescribable ferocity.

"The females and young, at the first cry, quickly disappear. He then approaches the enemy in great fury, pouring out his horrid cries in quick succession. The hunter awaits his approach with his gun extended; if his aim is not sure, he permits the animal to grasp the barrel, and as he carries it to his mouth (which is his habit) he fires. Should the gun fail to go off the barrel (that of the ordinary musket, which is thin) is crushed between his teeth, and the encounter soon proves fatal to the hunter.

"In the wild state, their habits are in general like those of the *Troglodytes niger*, building their nests loosely in trees, living on similar fruits, and changing their place of resort from force of circumstances."

Dr. Savage's observations were confirmed and supplemented by those of Mr. Ford, who communicated an interesting paper on the Gorilla to the Philadelphian Academy of Sciences, in 1852. With respect to the geographical distribution of this greatest of all the man-like Apes, Mr. Ford remarks:

"This animal inhabits the range of mountains that traverse the interior of Guinea, from the Cameroon in the north, to Angola in the

south, and about 100 miles inland, and called by the geographers Crystal Mountains. The limit to which this animal extends, either north or south, I am unable to define. But that limit is doubtless some distance north of this river [Gaboon]. I was able to certify myself of this fact in a late excursion to the head-waters of the Mooney (Danger) River, which comes into the sea some sixty miles from this place. I was informed (credibly, I think) that they were numerous among the mountains in which that river rises, and far north of that.

"In the south, this species extends to the Congo River, as I am told by native traders who have visited the coast between the Gaboon and that river. Beyond that, I am not informed. This animal is only found at a distance from the coast in most cases, and, according to my best information, approaches it nowhere so nearly as on the south side of this river, where they have been found within ten miles of the sea. This, however, is only of late occurrence. I am informed by some of the oldest Mpongwe men that formerly he was only found on the sources of the rivers, but that at present he may be found within half-a-day's walk of its mouth. Formerly he inhabited the mountainous ridge where Bushmen alone inhabited, but now he boldly approaches the Mpongwe plantations. This is doubtless the reason of the scarcity of information in years past, as the opportunities for receiving a knowledge of the animal have not been wanting; traders having for one hundred years frequented this river, and specimens, such as have been brought here within a year, could not have been exhibited without having attracted the attention of the most stupid."

One specimen Mr. Ford examined weighed 170 lbs., without the thoracic, or pelvic, viscera, and measured four feet four inches round the chest. This writer describes so minutely and graphically the onslaught of the Gorilla — though he does not for a moment pretend to have witnessed the scene — that I am tempted to give this part of his paper in full, for comparison with other narratives:

"He always rises to his feet when making an attack, though he approaches his antagonist in a stooping posture.

"Though he never lies in wait, yet, when he hears, sees, or scents a man, he immediately utters his characteristic cry, prepares for an attack, and always acts on the offensive. The cry he utters resembles a grunt more than a growl, and is similar to the cry of the Chimpanzee, when irritated, but vastly louder. It is said to be audible at a great distance. His preparation consists in attending the females and young ones, by whom he is usually accompanied, to a little distance. He, however, soon returns, with his crest erect and projecting forward, his nostrils dilated, and his under-lip thrown down, at the same time uttering his characteristic yell, designed, it would seem, to terrify his antagonist. Instantly, unless he is disabled by a well-directed shot, he makes an onset, and, striking his antagonist with the palm of his hands, or seizing him with

a grasp from which there is no escape, he dashes him upon the ground, and lacerates him with his tusks.

"He is said to seize a musket, and instantly crush the barrel between his teeth. . . . This animal's savage nature is very well shown by the implacable desperation of a young one that was brought here. It was taken very young, and kept four months, and many means were used to tame it; but it was incorrigible, so that it bit me an hour before it died."

Mr. Ford discredits the house-building and elephant-driving stories, and says that no well-informed natives believe them. They are tales told to children.

I might quote other testimony to a similar effect, but, as it appears to me, less carefully weighed and sifted, from the letters of MM. Franquet and Gautier Laboullay, appended to the memoir of M. I. G. St. Hilaire, which I have already cited.

Bearing in mind what is known regarding the Orang and the Gibbon, the statements of Dr. Savage and Mr. Ford do not appear to me to be justly open to criticism on *a priori* grounds. The Gibbons, as we have seen, readily assume the erect posture, but the Gorilla is far better fitted by its organisation for that attitude than are the Gibbons: if the laryngeal pouches of the Gibbons, as is very likely, are important in giving volume to a voice which can be heard for half a league, the Gorilla, which has similar sacs, more largely developed, and whose bulk is fivefold that of a Gibbon, may well be audible for twice that distance. If the Orang fights with its hands, the Gibbons and Chimpanzees with the teeth, the Gorilla may, probably enough, do either or both; nor is there anything to be said against either Chimpanzee or Gorilla building a nest, when it is proved that the Orang-Utan habitually performs that feat.

With all this evidence, now ten to fifteen years old, before the world, it is not a little surprising that the assertions of a recent traveller, who, so far as the Gorilla is concerned, really does very little more than repeat, on his own authority, the statements of Savage and of Ford, should have met with so much and such bitter opposition. If subtraction be made of what was known before, the sum and substance of what M. Du Chaillu has affirmed as a matter of his own observation respecting the Gorilla, is, that, in advancing to the attack, the great brute beats his chest with his fists. I confess I see nothing very improbable, or very much worth disputing about, in this statement.

With respect to the other man-like Apes of Africa, M. Du Chaillu tells us absolutely nothing, of his own knowledge, regarding the common Chimpanzee; but he informs us of a bald-headed species

or variety, the *nschiego mbouve,* which builds itself a shelter, and of another rare kind with a comparatively small face, large facial angle, and peculiar note, resembling "Kooloo."

As the Orang shelters itself with a rough coverlet of leaves, and the common Chimpanzee, according to that eminently trustworthy observer Dr. Savage, makes a sound like "Whoo-whoo,"—the grounds of the summary repudiation with which M. Du Chaillu's statements on these matters have been met are not obvious.

If I have abstained from quoting M. Du Chaillu's work, then, it is not because I discern any inherent improbability in his assertions respecting the man-like Apes; nor from any wish to throw suspicion on his veracity; but because, in my opinion, so long as his narrative remains in its present state of unexplained and apparently inexplicable confusion, it has no claim to original authority respecting any subject whatsoever.

It may be truth, but it is not evidence.

African Cannibalism in the Sixteenth Century.

In turning over Pigafetta's version of the narrative of Lopez, which I have quoted above, I came upon so curious and unexpected an anticipation, by some two centuries and a half, of one of the most startling parts of M. Du Chaillu's narrative, that I cannot refrain from drawing attention to it in a note, although I must confess that the subject is not strictly relevant to the matter in hand.

In the fifth chapter of the first book of the "Descriptio," "Concerning the northern part of the Kingdom of Congo and its boundaries," is mentioned a people whose king is called "Maniloango," and who live under the equator, and as far westward as Cape Lopez. This appears to be the country now inhabited by the Ogobai and Bakalai according to M. Du Chaillu.—"Beyond these dwell another people called 'Anziques,' of incredible ferocity, for they eat one another, sparing neither friends nor relations."

These people are armed with small bows bound tightly round with snake skins, and strung with a reed or rush. Their arrows, short and slender, but made of hard wood, are shot with great rapidity. They have iron axes, the handles of which are bound round with snake skins, and swords with scabbards of the same material; for defensive armour they employ elephant hides. They cut their skins when young, so as to produce scars. "Their butchers' shops are filled with human flesh instead of that of oxen or sheep. For they eat the enemies whom they take in battle. They fatten, slay and devour their slaves also, unless they think they shall get a good price for them; and, moreover, sometimes for weariness of life or desire of glory (for they think it a great thing and the sign of a generous soul to despise life), or for love of their rulers, offer themselves up for food."

"There are indeed many cannibals, as in the Eastern Indies and in

Brazil and elsewhere, but none such as these, since the others only eat their enemies, but these their own blood relations."

The careful illustrators of Pigafetta have done their best to enable the reader to realize this account of the "Anziques," and the unexampled butcher's shop represented in Fig. 12, is a facsimile of part of their Plate XII.

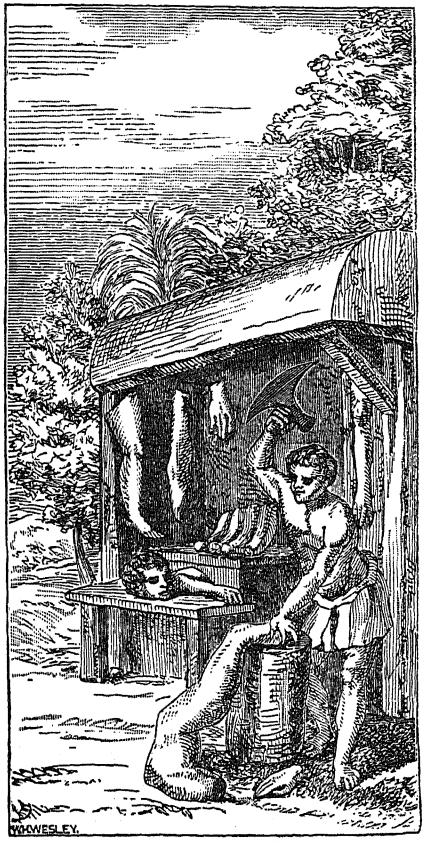
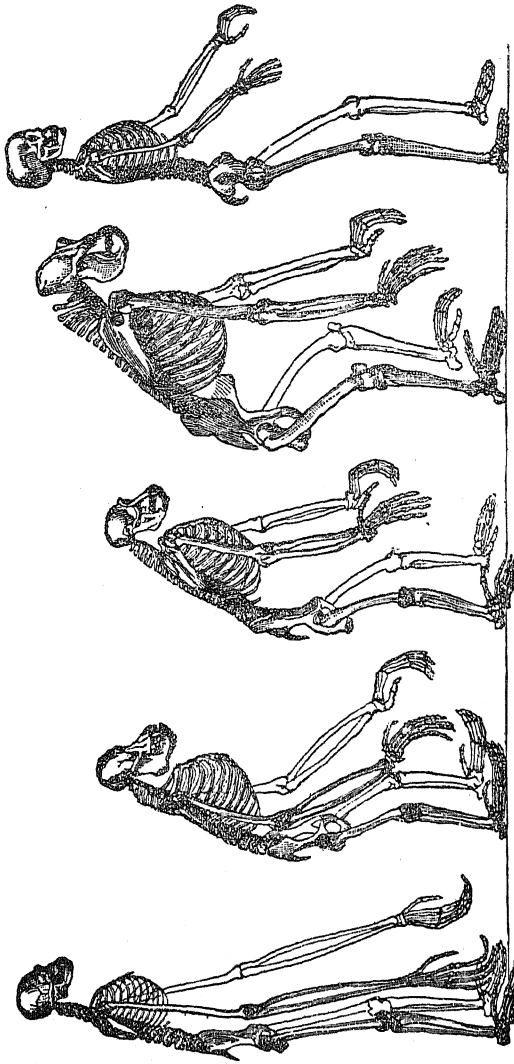


Fig. 12.—Butcher's Shop of the Anziques Anno 1598.

M. Du Chaillu's account of the Fans accords most singularly with what Lopez here narrates of the Anziques. He speaks of their small crossbows and little arrows, of their axes and knives, "ingeniously sheathed in snake skins." "They tattoo themselves more than any other tribes I have met north of the equator." And all the world knows what



Skeletons of the

Photographically reduced from Diagrams of the natural size (except that of the Gibbon, which was twice as large as nature), drawn by Mr. Waterhouse Hawkins from specimens in the Museum of the Royal College of Surgeons.

M. Du Chaillu says of their cannibalism—"Presently we passed a woman who solved all doubt. She bore with her a piece of the thigh of a human body, just as we should go to market and carry thence a roast or steak." M. Du Chaillu's artist cannot generally be accused of any want of courage in embodying the statements of his author, and it is to be regretted that, with so good an excuse, he has not furnished us with a fitting companion to the sketch of the brothers De Bry.

II.

ON THE RELATIONS OF MAN TO THE LOWER ANIMALS.

Multis videri poterit, majorem esse differentiam Simiæ et Hominis, quam diei et noctis; verum tamen hi, comparatione instituta inter summos Europæ Heroës et Hottentottes ad Caput bonæ spei degentes, difficillime sibi persuadebunt, has eosdem habere natales; vel si virginem nobilem aulicam, maxime comtam et humanissimam, conferre vellent cum homine sylvestri et sibi relicto, vix augurari possent, hunc et illam ejusdem esse speciei.—*Linnæi Amœnitates Acad.* "*Anthropomorpha.*"

THE question of questions for mankind — the problem which underlies all others, and is more deeply interesting than any other — is the ascertainment of the place which Man occupies in nature and of his relations to the universe of things. Whence our race has come; what are the limits of our power over nature, and of nature's power over us; to what goal we are tending; are the problems which present themselves anew and with undiminished interest to every man born into the world. Most of us, shrinking from the difficulties and dangers which beset the seeker after original answers to these riddles, are contented to ignore them altogether, or to smother the investigating spirit under the feather-bed of respected and respectable tradition. But, in every age, one or two restless spirits, blessed with that constructive genius, which can only build on a secure foundation, or cursed with the spirit of mere scepticism, are unable to follow in the well-worn and comfortable track of their forefathers and contemporaries, and unmindful of thorns and stumbling-blocks, strike out into paths of their own. The sceptics end in the infidelity which asserts the problem to be insoluble, or in the atheism which denies the existence of any orderly progress and governance of things: the men of genius propound solutions which grow into systems of Theology or of Philosophy, or veiled in musical language which suggests more than it asserts, take the shape of the Poetry of an epoch.

Each such answer to the great question, invariably asserted by the followers of its propounder, if not by himself, to be complete

and final, remains in high authority and esteem, it may be for one century, or it may be for twenty: but, as invariably, Time proves each reply to have been a mere approximation to the truth — tolerable chiefly on account of the ignorance of those by whom it was accepted, and wholly intolerable when tested by the larger knowledge of their successors.

In a well-worn metaphor, a parallel is drawn between the life of man and the metamorphosis of the caterpillar into the butterfly; but the comparison may be more just as well as more novel, if for its former term we take the mental progress of the race. History shows that the human mind, fed by constant accessions of knowledge, periodically grows too large for its theoretical coverings, and bursts them asunder to appear in new habiliments, as the feeding and growing grub, at intervals, casts its too narrow skin and assumes another, itself but temporary. Truly the imago state of Man seems to be terribly distant, but every moult is a step gained, and of such there have been many.

Since the revival of learning, whereby the Western races of Europe were enabled to enter upon that progress towards true knowledge, which was commenced by the philosophers of Greece, but was almost arrested in subsequent long ages of intellectual stagnation, or, at most, gyration, the human larva has been feeding vigorously, and moulting in proportion. A skin of some dimension was cast in the 16th century, and another towards the end of the 18th, while, within the last fifty years, the extraordinary growth of every department of physical science has spread among us mental food of so nutritious and stimulating a character that a new ecdysis seems imminent. But this is a process not unusually accompanied by many throes and some sickness and debility, or, it may be, by graver disturbances; so that every good citizen must feel bound to facilitate the process, and even if he have nothing but a scalpel to work withal, to ease the cracking integument to the best of his ability.

In this duty lies my excuse for the publication of these essays. For it will be admitted that some knowledge of man's position in the animate world is an indispensable preliminary to the proper understanding of his relations to the universe; and this again resolves itself, in the long run, into an inquiry into the nature and the closeness of the ties which connect him with those singular creatures whose history * has been sketched in the preceding pages.

The importance of such an inquiry is indeed intuitively manifest. Brought face to face with these blurred copies of himself,

* It will be understood that, in the preceding Essay, I have selected for notice from the vast mass of papers which have been written upon the man-like Apes, only those which seem to me to be of special moment.

the least thoughtful of men is conscious of a certain shock, due perhaps, not so much to disgust at the aspect of what looks like an insulting caricature, as to the awakening of a sudden and profound mistrust of time-honoured theories and strongly-rooted prejudices regarding his own position in nature, and his relations to the under-world of life; while that which remains a dim suspicion for the unthinking, becomes a vast argument, fraught with the deepest consequences, for all who are acquainted with the recent progress of the anatomical and physiological sciences.

I now propose briefly to unfold that argument, and to set forth, in a form intelligible to those who possess no special acquaintance with anatomical science, the chief facts upon which all conclusions respecting the nature and the extent of the bonds which connect man with the brute world must be based: I shall then indicate the one immediate conclusion which, in my judgment, is justified by those facts, and I shall finally discuss the bearing of that conclusion upon the hypotheses which have been entertained respecting the Origin of Man.

The facts to which I would first direct the reader's attention, though ignored by many of the professed instructors of the public mind, are easy of demonstration and are universally agreed to by men of science; while their significance is so great, that whoso has duly pondered over them will, I think, find little to startle him in the other revelations of Biology. I refer to those facts which have been made known by the study of Development.

It is a truth of very wide, if not of universal, appplication, that every living creature commences its existence under a form different from, and simpler than, that which it eventually attains.

The oak is a more complex thing than the little rudimentary plant contained in the acorn; the caterpillar is more complex than the egg; the butterfly than the caterpillar; and each of these beings, in passing from its rudimentary to its perfect condition, runs through a series of changes, the sum of which is called its Development. In the higher animals these changes are extremely complicated; but, within the last half century, the labours of such men as Von Baer, Rathke, Reichert, Bischoff, and Remak, have almost completely unravelled them, so that the successive stages of development which are exhibited by a Dog, for example, are now as well known to the embryologist as are the steps of the metamorphosis of the silk-worm moth to the school-boy. It will be useful to consider with attention the nature and the order of the stages of canine development, as an example of the process in the higher animals generally.

The dog, like all animals, save the very lowest (and further inquiries may not improbably remove the apparent exception), commences its existence as an egg: as a body which is, in every sense, as much an egg as that of a hen, but is devoid of that accumulation of nutritive matter which confers upon the bird's egg its exceptional size and domestic utility; and wants the shell, which would not only be useless to an animal incubated within the body of its parent, but would cut it off from access to the source of that nutriment which the young creature requires, but which the minute egg of the mammal does not contain within itself.

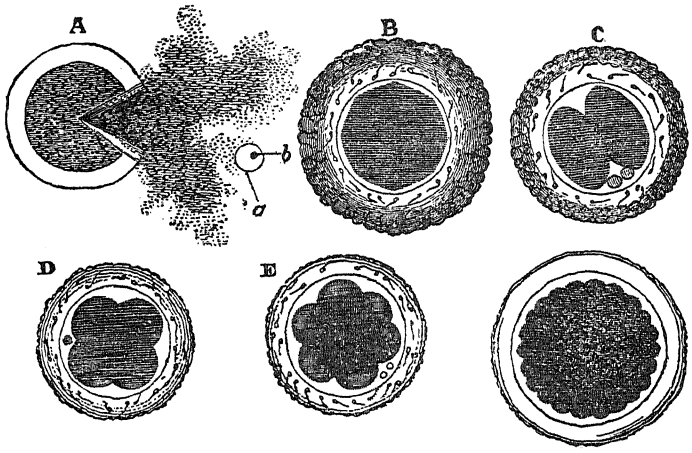


Fig. 13.—A. Egg of the Dog, with the vitelline membrane burst, so as to give exit to the yelk, the germinal vesicle (*a*), and its included spot (*b*). B. C. D. E. F. Successive changes of the yelk indicated in the text. After Bischoff.

The Dog's egg is, in fact, a little spheroidal bag (Fig. 13), formed of a delicate transparent membrane called the *vitelline membrane,* and about $\frac{1}{130}$th to $\frac{1}{120}$th of an inch in diameter. It contains a mass of viscid nutritive matter — the *yelk* — within which is enclosed a second much more delicate spheroidal bag, called the *germinal vesicle* (*a*). In this, lastly, lies a more solid rounded body, termed the *germinal spot* (*b*).

The egg, or *Ovum,* is originally formed within a gland, from which, in due season, it becomes detached, and passes into the living chamber fitted for its protection and maintenance during the protracted process of gestation. Here, when subjected to the required conditions, this minute and apparently insignificant particle of living matter becomes animated by a new and mysterious activ-

ity. The germinal vesicle and spot cease to be discernible (their precise fate being one of the yet unsolved problems of embryology), but the yelk becomes circumferentially indented, as if an invisible knife had been drawn round it, and thus appears divided into two hemispheres (Fig. 13, C).

By the repetition of this process in various planes, these hemispheres become subdivided, so that four segments are produced (D); and these, in like manner, divide and subdivide again, until the whole yelk is converted into a mass of granules, each of which consists of a minute spheroid of yelk-substance, inclosing a central particle, the so-called *nucleus* (F). Nature, by this process, has attained much the same result as that which a human artificer arrives at by his operations in a brick-field. She takes the rough plastic material of the yelk and breaks it up into well-shaped tolerably even-sized masses — handy for building up into any part of the living edifice.

Next, the mass of organic bricks, or *cells* as they are technically called, thus formed, acquires an orderly arrangement, becoming converted into a hollow spheroid with double walls. Then, upon one side of this spheroid, appears a thickening, and, by and bye, in the centre of the area of thickening, a straight shallow groove (Fig. 14, A) marks the central line of the edifice which is to be raised, or, in other words, indicates the position of the middle line of the body of the future dog. The substance bounding the groove on each side next rises up into a fold, the rudiment of the side wall of that long cavity, which will eventually lodge the spinal marrow and the brain; and in the floor of this chamber appears a solid cellular cord, the so-called *notochord*. One end of the enclosed cavity dilates to form the head (Fig. 14, B), the other remains narrow, and eventually becomes the tail; the side walls of the body are fashioned out of the downward continuation of the walls of the groove; and from them, by and bye, grow out little buds which, by degrees, assume the shape of limbs. Watching the fashioning process stage by stage, one is forcibly reminded of the modeller in clay. Every part, every organ, is at first, as it were pinched up rudely, and sketched out in the rough; then shaped more accurately; and only, at last, receives the touches which stamp its final character.

Thus, at length, the young puppy assumes such a form as is shown in Fig. 14, C. In this condition it has a disproportionately large head, as dissimilar to that of a dog as the bud-like limbs are unlike his legs.

The remains of the yelk, which have not yet been applied to the nutrition and growth of the young animal, are contained in a sac

attached to the rudimentary intestine, and termed the yelk sac, or *umbilical vesicle*. Two membranous bags, intended to subserve respectively the protection and nutrition of the young creature, have been developed from the skin and from the under and hinder surface of the body; the former, the so-called *amnion*, is a sac filled with fluid, which invests the whole body of the embryo, and plays the part of a sort of water-bed for it; the other, termed the *allantois*, grows out, loaded with blood-vessels, from the ventral region, and eventually applying itself to the walls of the cavity, in which the developing organism is contained, enables these vessels to become the channel by which the stream of nutriment, required to supply the wants of the offspring, is furnished to it by the parent.

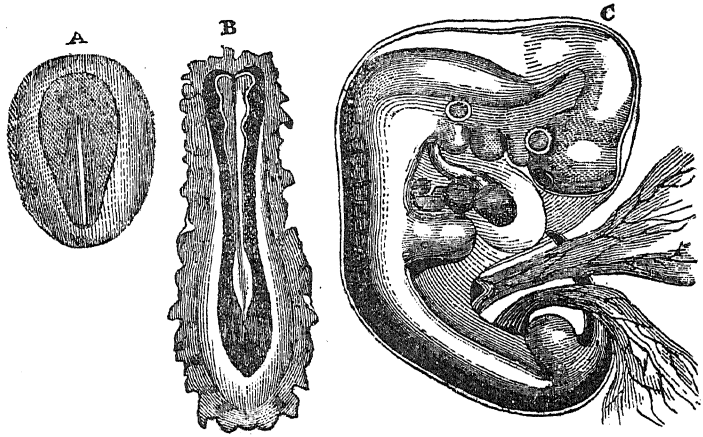


Fig. 14.—A. Earliest rudiment of the Dog. B. Rudiment further advanced, showing the foundations of the head, tail, and vertebral column. C. The very young puppy, with attached ends of the yelk-sac and allantois, and invested in the amnion.

The structure which is developed by the inter-lacement of the vessels of the offspring with those of the parent, and by means of which the former is enabled to receive nourishment and to get rid of effete matter, is termed the *Placenta*.

It would be tedious, and it is unnecessary for my present purpose, to trace the process of development further; suffice it to say, that, by a long and gradual series of changes, the rudiment here depicted and described, becomes a puppy, is born, and then, by still slower and less perceptible steps, passes into the adult Dog.

There is not much apparent resemblance between a barn-door Fowl and the Dog who protects the farm-yard. Nevertheless the

student of development finds, not only that the chick commences its existence as an egg, primarily identical, in all essential respects, with that of the Dog, but that the yelk of this egg undergoes division,— that the primitive groove arises, and that the contiguous parts of the germ are fashioned, by precisely similar methods, into a young chick, which, at one stage of its existence, is so like the nascent Dog, that ordinary inspection would hardly distinguish the two.

The history of the development of any other vertebrate animal, Lizard, Snake, Frog, or Fish, tells the same story. There is always, to begin with, an egg having the same essential structure as that of the Dog: — the yelk of that egg always undergoes division, or *segmentation* as it is often called: the ultimate products of that segmentation constitute the building materials for the body of the young animal; and this is built up round a primitive groove, in the floor of which a notochord is developed. Furthermore, there is a period in which the young of all these animals resemble one another, not merely in outward form, but in all essentials of structure, so closely, that the differences between them are inconsiderable, while, in their subsequent course they diverge more and more widely from one another. And it is a general law, that, the more closely any animals resemble one another in adult structure, the longer and the more intimately do their embryos resemble one another: so that, for example, the embryos of a Snake and of a Lizard remain like one another longer than do those of a Snake and of a Bird; and the embryo of a Dog and of a Cat remain like one another for a far longer period than do those of a Dog and a Bird; or of a Dog and an Opossum; or even than those of a Dog and a Monkey.

Thus the study of development affords a clear test of closeness of structural affinity, and one turns with impatience to inquire what results are yielded by the study of the development of Man. Is he something apart? Does he originate in a totally different way from Dog, Bird, Frog, and Fish, thus justifying those who assert him to have no place in nature and no real affinity with the lower world of animal life? Or does he originate in a similar germ, pass through the same slow and gradually progressive modifications, depend on the same contrivances for protection and nutrition, and finally enter the world by the help of the same mechanism? The reply is not doubtful for a moment, and has not been doubtful any time these thirty years. Without question, the mode of origin and the early stages of the development of man are identical with those of the animals immediately below him in the scale:

— without a doubt, in these respects, he is far nearer the Apes, than the Apes are to the Dog.

The Human ovum is about $\frac{1}{125}$th of an inch in diameter, and might be described in the same terms as that of the Dog, so that I need only refer to the figure illustrative (15 A) of its structure. It leaves the organ in which it is formed in a similar fashion and enters the organic chamber prepared for its reception in the same way, the conditions of its development being in all respects the same. It has not yet been possible (and only by some rare chance can it ever be possible) to study the human ovum in so early a developmental stage as that of yelk division, but there is every reason to conclude that the changes it undergoes are identical with those exhibited by the ova of other vertebrated animals; for the formative materials of which the rudimentary human body is composed, in the earliest conditions in which it has been observed, are the same as those of other animals. Some of these earliest stages

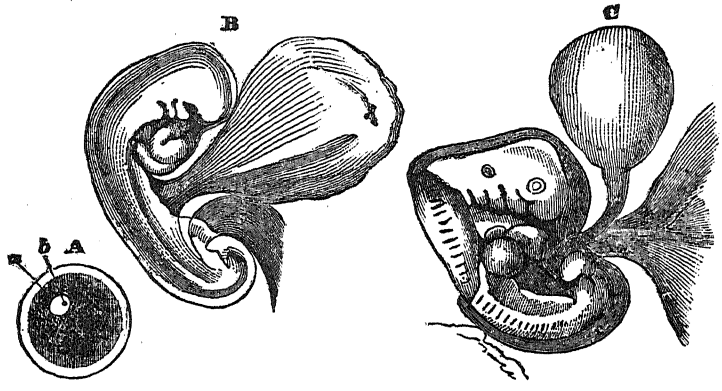


Fig. 15.— A. Human ovum (after Kölliker), *a*. germinal vesicle. *b*. germinal spot. B. A very early condition of Man, with yelk-sac, allantois and amnion (original.) C. A more advanced stage (after Kölliker), compare Fig. 14, C.

are figured above and, as will be seen, they are strictly comparable to the very early states of the Dog; the marvellous correspondence between the two which is kept up, even for some time, as development advances, becoming apparent by the simple comparison of the figures with those on page 50.

Indeed, it is very long before the body of the young human being can be readily discriminated from that of the young puppy; but, at a tolerably early period, the two become distinguishable by the different form of their adjuncts, the yelk-sac and the allantois. The former, in the Dog, becomes long and spindle-shaped, while in

Man it remains spherical: the latter, in the Dog, attains an extremely large size, and the vascular processes which are developed from it and eventually give rise to the formation of the placenta (taking root, as it were, in the parental organism, so as to draw nourishment therefrom, as the root of a tree extracts it from the soil) are arranged in an encircling zone, while in Man, the allantois remains comparatively small, and its vascular rootlets are eventually restricted to one disk-like spot. Hence, while the placenta of the Dog is like a girdle, that of Man has the cake-like form, indicated by the name of the organ.

But, exactly in those respects in which the developing Man differs from the Dog, he resembles the ape, which, like man, has a spheroidal yelk-sac and a discoidal, sometimes partially lobed, placenta. So that it is only quite in the later stages of development that the young human being presents marked differences from the young ape, while the latter departs as much from the dog in its development, as the man does.

Startling as the last assertion may appear to be, it is demonstrably true, and it alone appears to me sufficient to place beyond all doubt the structural unity of man with the rest of the animal world, and more particularly and closely with the apes.

Thus, identical in the physical processes by which he originates—identical in the early stages of his formation — identical in the mode of his nutrition before and after birth, with the animals which lie immediately below him in the scale — Man, if his adult and perfect structure be compared with theirs, exhibits, as might be expected, a marvellous likeness of organization. He resembles them as they resemble one another — he differs from them as they differ from one another.—And, though these differences and resemblances cannot be weighed and measured, their value may be readily estimated; the scale or standard of judgment, touching that value being afforded and expressed by the system of classification of animals now current among zoologists.

A careful study of the resemblances and differences presented by animals has, in fact, led naturalists to arrange them into groups, or assemblages, all the members of each group presenting a certain amount of definable resemblance, and the number of points of similarity being smaller as the group is larger and *vice versâ*. Thus, all creatures which agree only in presenting the few distinctive marks of animality form the *Kingdom* ANIMALIA. The numerous animals which agree only in possessing the special characters of Vertebrates form one *Sub-kingdom* of this Kingdom. Then the Sub-kingdom VERTEBRATA is subdivided into the five *Classes*,

Fishes, Amphibians, Reptiles, Birds, and Mammals, and these into smaller groups called *Orders;* these into *Families* and *Genera;* while the last are finally broken up into the smallest assemblages, which are distinguished by the possession of constant, not-sexual, characters. These ultimate groups are Species.

Every year tends to bring about a greater uniformity of opinion throughout the zoological world as to the limits and characters of these groups, great and small. At present, for example, no one has the least doubt regarding the characters of the classes Mammalia, Aves, or Reptilia; nor does the question arise whether any thoroughly well-known animal should be placed in one class or the other. Again, there is a very general agreement respecting the characters and limits of the orders of Mammals, and as to the animals which are structurally necessitated to take a place in one or another order.

No one doubts, for example, that the Sloth and the Ant-eater, the Kangaroo and the Opossum, the Tiger and the Badger, the Tapir and the Rhinoceros, are respectively members of the same orders. These successive pairs of animals may, and some do, differ from one another immensely, in such matters as the proportions and structure of their limbs; the number of their dorsal and lumbar vertebræ; the adaptation of their frames to climbing, leaping, or running; the number and form of their teeth; and the characters of their skulls and of the contained brain. But, with all these differences, they are so closely connected in all the more important and fundamental characters of their organization, and so distinctly separated by these same characters from other animals, that zoologists find it necessary to group them together as members of one order. And if any new animal were discovered, and were found to present no greater difference from the Kangaroo or from the Opossum, for example, than these animals do from one another, the zoologist would not only be logically compelled to rank it in the same order with these, but he would not think of doing otherwise.

Bearing this obvious course of zoological reasoning in mind, let us endeavour for a moment to disconnect our thinking selves from the mask of humanity; let us imagine ourselves scientific Saturnians, if you will, fairly acquainted with such animals as now inhabit the Earth, and employed in discussing the relations they bear to a new and singular "erect and featherless biped," which some enterprising traveller, overcoming the difficulties of space and gravitation, has brought from that distant planet for our inspection, well preserved, may be, in a cask of rum. We should all, at once, agree upon placing him among the mamma-

lian vertebrates; and his lower jaw, his molars, and his brain, would leave no room for doubting the systematic position of the new genus among those mammals, whose young are nourished during gestation by means of a placenta, or what are called the "placental mammals."

Further, the most superficial study would at once convince us that, among the orders of placental mammals, neither the Whales, nor the hoofed creatures, nor the Sloths and Ant-eaters, nor the carnivorous Cats, Dogs, and Bears, still less the Rodent Rats and Rabbits, or the Insectivorous Moles and Hedgehogs, or the Bats, could claim our *Homo,* as one of themselves.

There would remain then but one order for comparison, that of the Apes (using the word in its broadest sense), and the question for discussion would narrow itself to this — is Man so different from any of these Apes that he must form an order by himself? Or does he differ less from them than they differ from one another, and hence must take his place in the same order with them?

Being happily free from all real, or imaginary, personal interest in the results of the inquiry thus set afoot, we should proceed to weigh the arguments on one side and on the other, with as much judicial calmness as if the question related to a new Opossum. We should endeavour to ascertain, without seeking either to magnify or diminish them, all the characters by which our new Mammal differed from the Apes; and if we found that these were of less structural value than those which distinguish certain members of the Ape order from others universally admitted to be of the same order, we should undoubtedly place the newly discovered tellurian genus with them.

I now proceed to detail the facts which seem to me to leave us no choice but to adopt the last-mentioned course.

It is quite certain that the Ape which most nearly approaches man, in the totality of its organisation, is either the Chimpanzee or the Gorilla; and as it makes no practical difference, for the purposes of my present argument, which is selected for comparison, on the one hand, with Man, and on the other hand, with the rest of the Primates,* I shall select the latter (so far as its organisation is known) — as a brute now so celebrated in prose and verse, that all must have heard of him, and have formed some conception of his appearance. I shall take up as many of the most important points of difference between man and this re-

* We are not at present thoroughly acquainted with the brain of the Gorilla, and therefore, in discussing cerebral characters, I shall take that of the Chimpanzee as my highest term among the Apes.

markable creature, as the space at my disposal will allow me to discuss; and the necessities of the argument demand; and I shall inquire into the value and magnitude of these differences, when placed side by side with those which separate the Gorilla from other animals of the same order.

In the general proportions of the body and limbs there is a remarkable difference between the Gorilla and Man, which at once strikes the eye. The Gorilla's brain-case is smaller, its trunk larger, its lower limbs shorter, its upper limbs longer in proportion than those of Man.

I find that the vertebral column of a full-grown Gorilla, in the Museum of the Royal College of Surgeons, measures 27 inches along its anterior curvature, from the upper edge of the atlas, or first vertebra of the neck, to the lower extremity of the sacrum; that the arm, without the hand, is 31½ inches long; that the leg, without the foot, is 26½ inches long; that the hand is 9¾ inches long; the foot 11¼ inches long.

In other words, taking the length of the spinal column as 100, the arm equals 115, the leg 96, the hand 36, and the foot 41.

In the skeleton of a male Bosjesman, in the same collection, the proportions, by the same measurement, to the spinal column, taken as 100, are — the arm 78, the leg 110, the hand 26, and the foot 32. In a woman of the same race the arm is 83, and the leg 120, the hand and foot remaining the same. In a European skeleton I find the arm to be 80, the leg 117, the hand 26, the foot 35.

Thus the leg is not so different as it looks at first sight, in its proportion to the spine in the Gorilla and in the Man — being very slightly shorter than the spine in the former, and between $\frac{1}{10}$ and $\frac{1}{9}$ longer than the spine in the latter. The foot is longer and the hand much longer in the Gorilla; but the great difference is caused by the arms, which are very much longer than the spine in the Gorilla, very much shorter than the spine in the Man.

The question now arises how are the other Apes related to the Gorilla in these respects — taking the length of the spine, measured in the same way, at 100. In an adult Chimpanzee, the arm is only 96, the leg 90, the hand 43, the foot 39 — so that the hand and the leg depart more from the human proportion and the arm less, while the foot is about the same as in the Gorilla.

In the Orang, the arms are very much longer than in the Gorilla (122), while the legs are shorter (88); the foot is longer

than the hand (52 and 48), and both are much longer in proportion to the spine.

In the other man-like Apes again, the Gibbons, these proportions are still further altered; the length of the arms being to that of the spinal column as 19 to 11; while the legs are also a third longer than the spinal column, so as to be longer than in Man, instead of shorter. The hand is half as long as the spinal column, and the foot, shorter than the hand, is about $\frac{5}{11}$ths of the length of the spinal column.

Thus *Hylobates* is as much longer in the arms than the Gorilla, as the Gorilla is longer in the arms than Man; while, on the other hand, it is as much longer in the legs than the Man, as the Man is longer in the legs than the Gorilla, so that it contains within itself the extremest deviations from the average length of both pairs of limbs.*

The Mandrill presents a middle condition, the arms and legs being nearly equal in length, and both being shorter than the spinal column; while hand and foot have nearly the same proportions to one another and to the spine, as in Man.

In the Spider Monkey (*Ateles*) the leg is longer than the spine, and the arm than the leg; and, finally, in that remarkable Lemurine form, the Indri (*Lichanotus*), the leg is about as long as the spinal column, while the arm is not more than $\frac{11}{18}$ of its length; the hand having rather less and the foot rather more, than one third the length of the spinal column.

These examples might be greatly multiplied, but they suffice to show that, in whatever proportion of its limbs the Gorilla differs from Man, the other Apes depart still more widely from the Gorilla and that, consequently, such differences of proportion can have no ordinal value.

We may next consider the differences presented by the trunk, consisting of the vertebral column, or backbone, and the ribs and pelvis, or bony hip-basin, which are connected with it, in Man and in the Gorilla respectively.

In Man, in consequence partly of the disposition of the articular surfaces of the vertebræ, and largely of the elastic tension of some of the fibrous bands, or ligaments, the spinal column, as a whole, has an elegant S-like curvature, being convex forwards in the neck, concave in the back, convex in the loins, or lumbar region, and concave again in the sacral region; an arrangement which gives much elasticity to the whole backbone, and

* See the figures of the skeletons of four anthropoid apes and of man, drawn to scale, p. 44.

diminishes the jar communicated to the spine, and through it to the head, by locomotion in the erect position.

Furthermore, under ordinary circumstances, Man has seven vertebræ in his neck, which are called *cervical;* twelve succeed these, bearing ribs and forming the upper part of the back, whence they are termed *dorsal;* five lie in the loins, bearing no distinct, or free ribs, and are called *lumbar;* five, united together into a great bone, excavated in front, solidly wedged in between the hip bones, to form the back of the pelvis, and known by the name of the *sacrum,* succeed these; and finally, three or four little more or less movable bones, so small as to be insignificant, constitute the *coccyx* or rudimentary tail.

In the Gorilla, the vertebral column is similarly divided into cervical, dorsal, lumbar, sacral, and coccygeal vertebræ, and the total number of cervical and dorsal vertebræ, taken together, is the same as in Man; but the development of a pair of ribs to the first lumbar vertebra, which is an exceptional occurrence in Man, is the rule in the Gorilla; and hence, as lumbar are distinguished from dorsal vertebræ only by the presence or absence of free ribs, the seventeen "dorso-lumbar" vertebræ of the Gorilla are divided into thirteen dorsal and four lumbar, while in Man they are twelve dorsal and five lumbar.

Not only, however, does Man occasionally possess thirteen pair of ribs,* but the Gorilla sometimes has fourteen pairs, while an Orang-Utan skeleton in the Museum of the Royal College of Surgeons has twelve dorsal and five lumbar vertebræ, as in Man. Cuvier notes the same number in a *Hylobates.* On the other hand, among the lower Apes, many possess twelve dorsal and six or seven lumbar vertebræ; the Douroucouli has fourteen dorsal and eight lumbar, and a Lemur (*Stenops tardigradus*) has fifteen dorsal and nine lumbar vertebræ.

The vertebral column of the Gorilla, as a whole, differs from that of Man in the less marked character of its curves, especially in the slighter convexity of the lumbar region. Nevertheless, the curves are present, and are quite obvious in young skeletons of the Gorilla and Chimpanzee which have been prepared without removal of the ligaments. In young Orangs similarly preserved

* "More than once," says Peter Camper, "have I met with more than six lumbar vertebræ in man. . . . Once I found thirteen ribs and four lumbar vertebræ." Fallopius noted thirteen pair of ribs and only four lumbar vertebræ; and Eustachius once found eleven dorsal vertebræ and six lumbar vertebræ.—*Œuvres de Pierre Camper,* T. 1, p. 42. As Tyson states, his "Pygmie" had thirteen pair of ribs and five lumbar vertebræ. The question of the curves of the spinal column in the Apes requires further investigation.

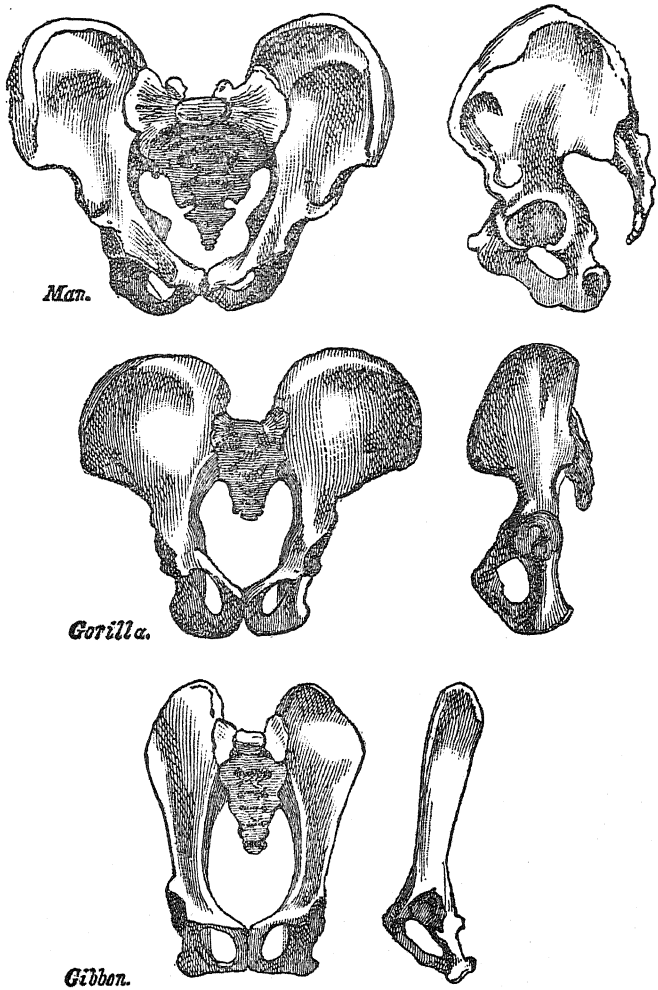


Fig. 16.—Front and side views of the bony pelvis of Man, the Gorilla and Gibbon: reduced from drawings made from nature, of the same absolute length, by Mr. Waterhouse Hawkins.

on the other hand, the spinal column is either straight, or even concave forwards, throughout the lumbar region.

Whether we take these characters then, or such minor ones as those which are derivable from the proportional length of the spines of the cervical vertebræ, and the like, there is no doubt

whatsoever as to the marked difference between Man and the Gorilla; but there is as little, that equally marked differences, of the very same order, obtain between the Gorilla and the lower Apes.

The Pelvis, or bony girdle of the hips, of Man is a strikingly human part of his organisation; the expanded haunch bones affording support for his viscera during his habitually erect posture, and giving space for the attachment of the great muscles which enable him to assume and to preserve that attitude. In these respects the pelvis of the Gorilla differs very considerably from his (Fig. 16). But go no lower than the Gibbon, and see how vastly more he differs from the Gorilla than the latter does from Man, even in this structure. Look at the flat, narrow haunch bones — the long and narrow passage — the coarse, outwardly curved, ischiatic prominences on which the Gibbon habitually rests, and which are coated by the so-called "callosities," dense patches of skin, wholly absent in the Gorilla, in the Chimpanzee, and in the Orang, as in Man!

In the lower Monkeys and in the Lemurs the difference becomes more striking still, the pelvis acquiring an altogether quadrupedal character.

But now let us turn to a nobler and more characteristic organ — that by which the human frame seems to be, and indeed is, so strongly distinguished from all others,— I mean the skull. The differences between a Gorilla's skull and a Man's are truly immense (Fig. 17). In the former, the face, formed largely by the massive jaw-bones, predominates over the brain-case, or cranium proper: in the latter, the proportions of the two are reversed. In the Man, the occipital foramen, through which passes the great nervous cord connecting the brain with the nerves of the body, is placed just behind the centre of the base of the skull, which thus becomes evenly balanced in the erect posture; in the Gorilla, it lies in the posterior third of that base. In the Man, the surface of the skull is comparatively smooth, and the supraciliary ridges or brow prominences usually project but little — while, in the Gorilla, vast crests are developed upon the skull, and the brow ridges overhang the cavernous orbits, like great penthouses.

Sections of the skulls, however, show that some of the apparent defects of the Gorilla's cranium arise, in fact, not so much from deficiency of brain-case as from excessive development of the parts of the face. The cranial cavity is not ill-shaped, and the forehead is not truly flattened or very retreating, its really well-formed curve being simply disguised by the mass of bone which is built up against it (Fig. 17).

But the roofs of the orbits rise more obliquely into the cranial cavity, thus diminishing the space for the lower part of the anterior lobes of the brain, and the absolute capacity of the cranium is far less than that of Man. So far as I am aware, no human cranium belonging to an adult man has yet been observed with a less cubical capacity than 62 cubic inches, the smallest cranium observed in any race of men by Morton, measuring 63 cubic inches; while, on the other hand, the most capacious Gorilla skull yet measured has a content of not more than 34½ cubic inches. Let us assume, for simplicity's sake, that the lowest Man's skull has twice the capacity of that of the highest Gorilla.*

No doubt, this is a very striking difference, but it loses much of its apparent systematic value, when viewed by the light of certain other equally indubitable facts respecting cranial capacities.

The first of these is, that the difference in the volume of the cranial cavity of different races of mankind is far greater, absolutely, than that between the lowest Man and the highest Ape, while, relatively, it is about the same. For the largest human skull measured by Morton contained 114 cubic inches, that is to say, had very nearly double the capacity of the smallest; while its absolute preponderance, of 52 cubic inches — is far greater than that by which the lowest adult male human cranium surpasses the largest of the Gorillas (62 — 34½ = 27½). Secondly, the adult crania of Gorillas which have as yet been measured differ among

* It has been affirmed that Hindoo crania sometimes contain as little as 27 ounces of water, which would give a capacity of about 46 cubic inches. The minimum capacity which I have assumed above, however, is based upon the valuable tables published by Professor R. Wagner in his *Vorstudien zu einer wissenschaftlichen Morphologie und Physiologie des menschlichen Gehirns*. As the result of the careful weighing of more than 900 human brains, Professor Wagner states that one-half weighed between 1200 and 1400 grammes, and that about two-ninths, consisting for the most part of male brains, exceed 1400 grammes. The lightest brain of an adult male, with sound mental faculties, recorded by Wagner, weighed 1020 grammes. As a gramme equals 15.4 grains, and a cubic inch of water contains 252.4 grains, this is equivalent to 62 cubic inches of water; so that as brain is heavier than water, we are perfectly safe against erring on the side of diminution in taking this as the smallest capacity of any adult male human brain. The only adult male brain, weighing as little as 970 grammes, is that of an idiot; but the brain of an adult woman, against the soundness of whose faculties nothing appears, weighed as little as 907 grammes (55.3 cubic inches of water); and Reid gives an adult female brain of still smaller capacity. The heaviest brain (1872 grammes, or about 115 cubic inches) was, however, that of a woman; next to it comes the brain of Cuvier (1861 grammes), then Byron (1807 grammes), and then an insane person (1783 grammes). The lightest adult brain recorded (720 grammes) was that of an idiotic female. The brains of five children, four years old, weighed between 1275 and 992 grammes. So that it may be safely said, that an average European child of four years old has a brain twice as large as that of an adult Gorilla.

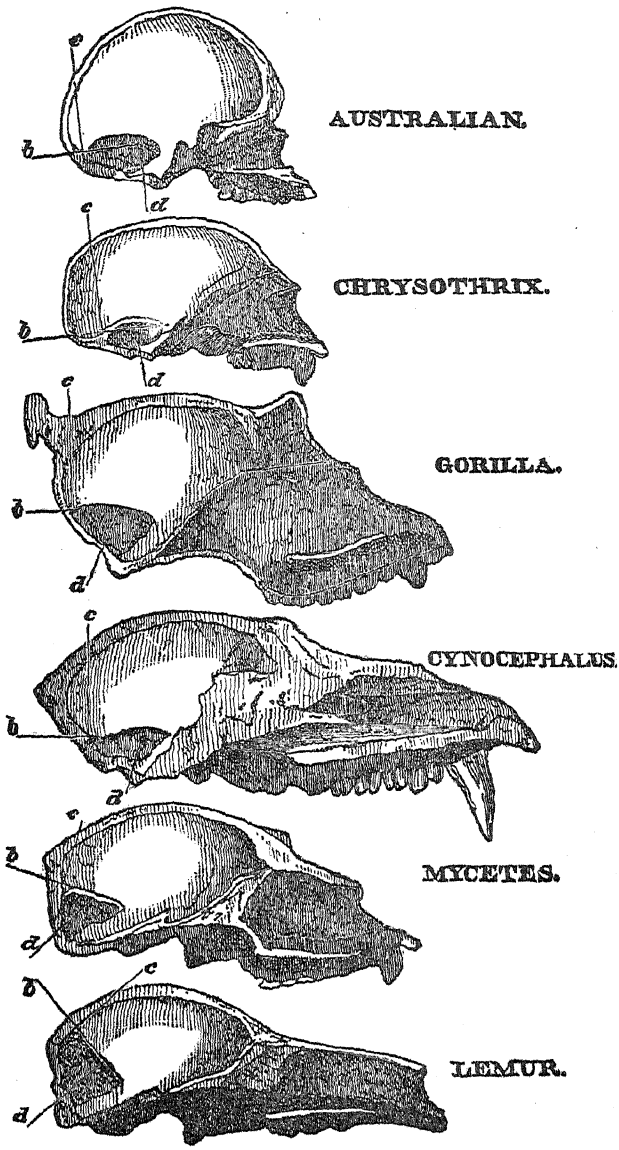


Fig. 17.—Sections of the skulls of Man and various Apes, drawn so as to give the cerebral cavity the same length in each case, thereby dis-

playing the varying proportions of the facial bones. The line *b* indicates the plane of the tentorium, which separates the cerebrum from the cerebellum; *d*, the axis of the occipital outlet of the skull. The extent of cerebral cavity behind *c*, which is a perpendicular erected on *b* at the point where the tentorium is attached posteriorly, indicates the degree to which the cerebrum overlaps the cerebellum — the space occupied by which is roughly indicated by the dark shading. In comparing these diagrams, it must be recollected, that figures on so small a scale as these simply exemplify the statements in the text, the proof of which is to be found in the objects themselves.

themselves by nearly one-third, the maximum capacity being 34.5 cubic inches, the minimum 24 cubic inches; and, thirdly, after making all due allowance for difference of size, the cranial capacities of some of the lower Apes fall nearly as much, relatively, below those of the higher Apes as the latter fall below Man.

Thus, even in the important matter of cranial capacity, Men differ more widely from one another than they do from the Apes; while the lowest Apes differ as much, in proportion, from the highest, as the latter does from Man. The last proposition is still better illustrated by the study of the modifications which other parts of the cranium undergo in the Simian series.

It is the large proportional size of the facial bones and the great projection of the jaws which confer upon the Gorilla's skull its small facial angle and brutal character.

But if we consider the proportional size of the facial bones to the skull proper only, the little *Chrysothrix* (Fig. 17) differs very widely from the Gorilla, and, in the same way, as Man does; while the Baboons (*Cynocephalus*, Fig. 17) exaggerate the gross proportions of the muzzle of the great Anthropoid, so that its visage looks mild and human by comparison with theirs. The difference between the Gorilla and the Baboon is even greater than it appears at first sight; for the great facial mass of the former is largely due to a downward development of the jaws; an essentially human character, superadded upon that almost purely forward, essentially brutal development of the same parts which characterises the Baboon, and yet more remarkably distinguishes the Lemur.

Similarly, the occipital foramen of *Mycetes* (Fig. 17), and still more of the Lemurs, is situated completely in the posterior face of the skull, or as much further back than that of the Gorilla, as that of the Gorilla is further back than that of Man; while, as if to render patent the futility of the attempt to base any broad classificatory distinction on such a character, the same group of Platyrhine, or American monkeys, to which the *Mycetes* belongs, contains the *Chrysothrix*, whose occipital foramen is situated far more forward than in any other ape, and nearly approaches the position it holds in Man.

Again, the Orang's skull is as devoid of excessively developed supraciliary prominences as a Man's, though some varieties exhibit great crests elsewhere (See p. 15); and in some of the Cebine apes and in the *Chrysothrix,* the cranium is as smooth and rounded as that of Man himself.

What is true of these leading characteristics of the skull, holds good, as may be imagined, of all minor features; so that for every constant difference between the Gorilla's skull and the Man's a similar constant difference of the same order (that is to say, consisting in excess or defect of the same quality) may be found between the Gorilla's skull and that of some other ape. So that, for the skull, no less than for the skeleton in general, the proposition holds good, that the differences between Man and the Gorilla are of smaller value than those between the Gorilla and some other Apes.

In connection with the skull, I may speak of the teeth — organs which have a peculiar classificatory value, and whose resemblances and differences of number, form, and succession, taken as a whole, are usually regarded as more trustworthy indicators of affinity than any others.

Man is provided with two sets of teeth — milk teeth and permanent teeth. The former consist of four incisors, or cutting teeth; two canines, or eye-teeth; and four molars or grinders, in each jaw, making twenty in all. The latter (Fig. 18) comprises four incisors, two canines, four small grinders, called premolars or false molars, and six large grinders, or true molars in each jaw — making thirty-two in all. The internal incisors are larger than the external pair, in the upper jaw, smaller than the external pair, in the lower jaw. The crowns of the upper molars exhibit four cusps, or blunt-pointed elevations, and a ridge crosses the crown obliquely, from the inner anterior cusp to the outer posterior cusp (Fig. 18 m^2). The anterior lower molars have five cusps, three external and two internal. The premolars have two cusps, one internal and one external, of which the outer is the higher.

In all these respects the dentition of the Gorilla may be described in the same terms as that of Man; but in other matters it exhibits many and important differences (Fig. 18).

Thus the teeth of man constitute a regular and even series — without any break and without any marked projection of one tooth above the level of the rest; a peculiarity which, as Cuvier long ago showed, is shared by no other mammal save one — as different a creature from man as can well be imagined — namely, the long extinct *Anoplotherium.* The teeth of the Gorilla, on the

contrary, exhibit a break, or interval, termed the *diastema,* in both jaws: in front of the eye-tooth, or between it and the outer incisor, in the upper jaw; behind the eye-tooth, or between it and the front false molar, in the lower jaw. Into this break in the series, in

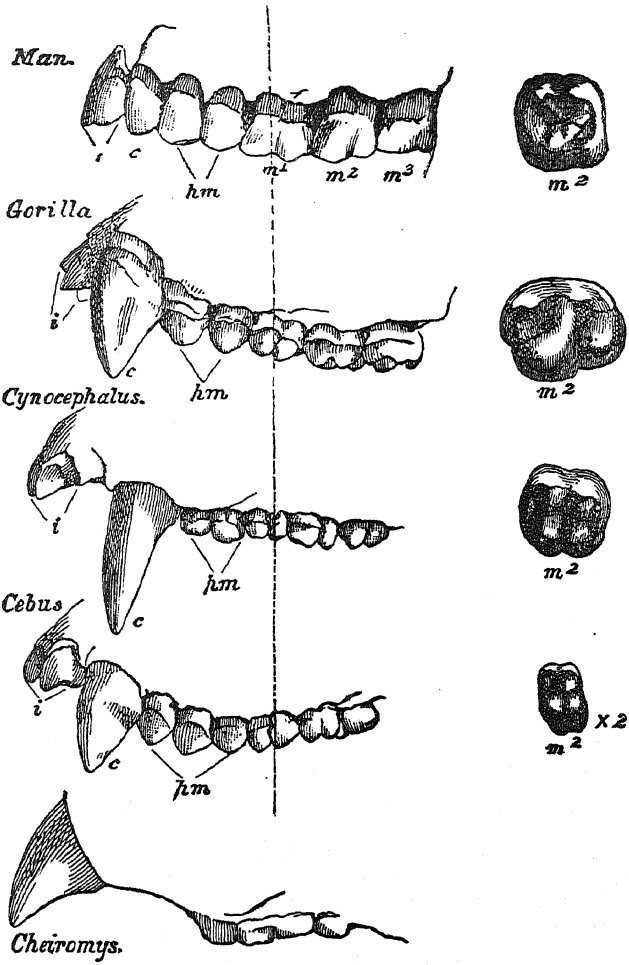


Fig. 18.—Lateral views, of the same length, of the upper jaws of various Primates. *i,* incisors; *c,* canines; *pm,* premolars; *m,* molars. A line is drawn through the first molar of Man, *Gorilla, Cynocephalus,* and *Cebus,* and the grinding surface of the second molar is shown in each, its anterior and internal angle being just above the *m* of m^2.

each jaw, fits the canine of the opposite jaw; the size of the eye-tooth in the Gorilla being so great that it projects, like a tusk, far beyond the general level of the other teeth. The roots of the false molar teeth of the Gorilla, again, are more complex than in Man, and the proportional size of the molars is different. The Gorilla has the crown of the hindmost grinder of the lower jaw more complex, and the order of eruption of the permanent teeth is different; the permanent canines making their appearance before the second and third molars in Man, and after them in the Gorilla.

Thus, while the teeth of the Gorilla closely resemble those of Man in number, kind, and in the general pattern of their crowns, they exhibit marked differences from those of Man in secondary respects, such as relative size, number of fangs, and order of appearance.

But, if the teeth of a Gorilla be compared with those of an Ape, no further removed from it than a *Cynocephalus,* or Baboon, it will be found that differences and resemblances of the same order are easily observable; but that many of the points in which the Gorilla resembles Man are those in which it differs from the Baboon; while various respects in which it differs from Man are exaggerated in the *Cynocephalus.* The number and the nature of the teeth remain the same in the Baboon as in the Gorilla and in Man. But the pattern of the Baboon's upper molars is quite different from that described above (Fig. 18), the canines are proportionally longer and more knife-like; the anterior premolar in the lower jaw is specially modified; the posterior molar of the lower jaw is still larger and more complex than in the Gorilla.

Passing from the old-world Apes to those of the new world, we meet with a change of much greater importance than any of these. In such a genus as *Cebus,* for example (Fig. 18), it will be found that while in some secondary points, such as the projection of the canines and the diastema, the resemblance to the great ape is preserved; in other and most important respects, the dentition is extremely different. Instead of 20 teeth in the milk set, there are 24: instead of 32 teeth in the permanent set, there are 36, the false molars being increased from eight to twelve. And in form, the crowns of the molars are very unlike those of the Gorilla, and differ far more widely from the human pattern.

The Marmosets, on the other hand, exhibit the same number of teeth as Man and the Gorilla; but, notwithstanding this, their dentition is very different, for they have four more false molars, like the other American monkeys — but as they have four fewer true molars, the total remains the same. And passing from the

American Apes to the Lemurs, the dentition becomes still more completely and essentially different from that of the Gorilla. The incisors begin to vary both in number and in form. The molars acquire, more and more, a many-pointed, insectivorous character, and in one Genus, the Aye-Aye (*Cheiromys*), the canines disappear, and the teeth completely simulate those of a Rodent (Fig. 18).

Hence it is obvious that, greatly as the dentition of the highest Ape differs from that of Man, it differs far more widely from that of the lower and lowest Apes.

Whatever part of the animal fabric — whatever series of muscles, whatever viscera might be selected for comparison — the result would be the same — the lower Apes and the Gorilla would differ more than the Gorilla and the Man. I cannot attempt in this place to follow out all these comparisons in detail, and indeed it is unnecessary I should do so. But certain real, or supposed, structural distinctions between Man and the Apes remain, upon which so much stress has been laid, that they require careful consideration, in order that the true value may be assigned to those which are real, and the emptiness of those which are fictitious may be exposed. I refer to the characters of the hand, the foot, and the brain.

Man has been defined as the only animal possessed of two hands terminating his fore limbs, and of two feet ending his hind limbs, while it has been said that all the apes possess four hands; and he has been affirmed to differ fundamentally from all the apes in the characters of his brain, which alone, it has been strangely asserted and reasserted, exhibits the structures known to anatomists as the posterior lobe, the posterior cornu of the lateral ventricle, and the hippocampus minor.

That the former proposition should have gained general acceptance is not surprising — indeed, at first sight, appearances are much in its favour: but, as for the second, one can only admire the surpassing courage of its enunciator, seeing that it is an innovation which is not only opposed to generally and justly accepted doctrines, but which is directly negatived by the testimony of all original inquirers, who have specially investigated the matter: and that it neither has been, nor can be, supported by a single anatomical preparation. It would, in fact, be unworthy of serious refutation, except for the general and natural belief that deliberate and reiterated assertions must have some foundation.

Before we can discuss the first point with advantage we must consider with some attention, and compare together, the structure

of the human hand and that of the human foot, so that we may have distinct and clear ideas of what constitutes a hand and what a foot.

The external form of the human hand is familiar enough to every one. It consists of a stout wrist followed by a broad palm, formed of flesh, and tendons, and skin, binding together four bones, and dividing into four long and flexible digits, or fingers, each of which bears on the back of its last joint a broad and flattened nail. The longest cleft between any two digits is rather less than half as long as the hand. From the outer side of the base of the palm a stout digit goes off, having only two joints instead of three; so short, that it only reaches to a little beyond the middle of the first joint of the finger next it; and further remarkable by its great mobility, in consequence of which it can be directed outwards, almost at a right angle to the rest. This digit is called the "*pollex*," or thumb; and, like the others, it bears a flat nail upon the back of its terminal joint. In consequence of the proportions and mobility of the thumb, it is what is termed "opposable"; in other words, its extremity can, with the greatest ease, be brought into contact with the extremities of any of the fingers; a property upon which the possibility of our carrying into effect the conceptions of the mind so largely depends.

The external form of the foot differs widely from that of the hand; and yet, when closely compared, the two present some singular resemblances. Thus the ankle corresponds in a manner with the wrist; the sole with the palm; the toes with the fingers; the great toe with the thumb. But the toes, or digits of the foot, are far shorter in proportion than the digits of the hand, and are less moveable, the want of mobility being most striking in the great toe — which, again, is very much larger in proportion to the other toes than the thumb to the fingers. In considering this point, however, it must not be forgotten that the civilized great toe, confined and cramped from childhood upwards, is seen to great disadvantage, and that in uncivilized and barefooted people it retains a great amount of mobility, and even some sort of opposability. The Chinese boatmen are said to be able to pull an oar; the artisans of Bengal to weave, and the Carajas to steal fishhooks by its help; though, after all, it must be recollected that the structure of its joints and the arrangement of its bones, necessarily render its prehensile action far less perfect than that of the thumb.

But to gain a precise conception of the resemblances and differences of the hand and foot, and of the distinctive characters of each, we must look below the skin, and compare the bony framework and its motor apparatus in each (Fig. 19).

The skeleton of the hand exhibits, in the region which we term the wrist, and which is technically called the *carpus* — two rows of closely fitted polygonal bones, four in each row, which are tolerably equal in size. The bones of the first row with the bones of the forearm, form the wrist joint, and are arranged side by side, no one greatly exceeding or overlapping the rest.

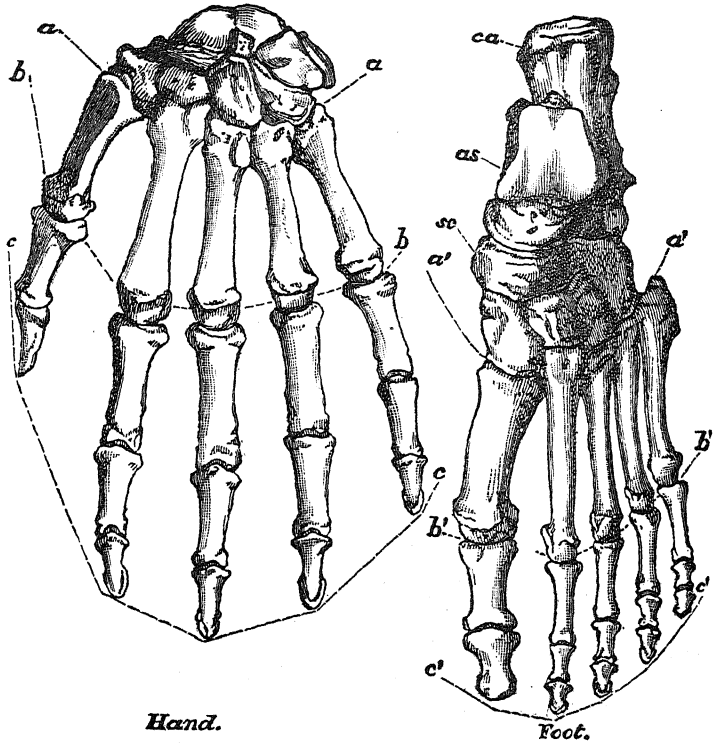


Fig. 19.—The skeleton of the Hand and Foot of Man reduced from Dr. Carter's drawings in Gray's *Anatomy*. The hand is drawn to a larger scale than the foot. The line *a a* in the hand indicates the boundary between the carpus and the metacarpus; *b b* that between the latter and the proximal phalanges; *c c* marks the ends of the distal phalanges. The line *a' a'* in the foot indicates the boundary between the tarsus and metatarsus; *b' b'* marks that between the metatarsus and the proximal phalanges; and *c' c'* bounds the ends of the distal phalanges; *ca*, the calcaneum; *as*, the astragalus; *sc*, the scaphoid bone in the tarsus.

Three of the bones of the second row of the carpus bear the four long bones which support the palm of the hand. The fifth bone of the same character is articulated in a much more free and

moveable manner than the others, with its carpal bone, and forms the base of the thumb. These are called *metacarpal* bones, and they carry the *phalanges* or bones of the digits, of which there are two in the thumb, and three in each of the fingers.

The skeleton of the foot is very like that of the hand in some respects. Thus there are three phalanges in each of the lesser toes, and only two in the great toe, which answers to the thumb. There is a long bone, termed *metatarsal,* answering to the metacarpal, for each digit; and the *tarsus* which corresponds with the carpus, presents four short polygonal bones in a row, which correspond very closely with the four carpal bones of the second row of the hand. In other respects the foot differs very widely from the hand. Thus the great toe is the longest digit but one; and its metatarsal is far less moveably articulated with the tarsus than the metacarpal of the thumb with the carpus. But a far more important distinction lies in the fact that, instead of four more tarsal bones there are only three; and, that these three are not arranged side by side, or in one row. One of them, the *os calcis* or heel bone (*ca*), lies externally, and sends back the large projecting heel; another, the *astragalus* (*as*), rests on this by one face, and by another, forms, with the bones of the leg, the ankle joint; while a third face, directed forwards, is separated from the three inner tarsal bones of the row next the metatarsus by a bone called the *scaphoid* (*sc*).

Thus there is a fundamental difference in the structure of the foot and the hand, observable when the carpus and the tarsus are contrasted: and there are differences of degree noticeable when the proportions and the mobility of the metacarpals and metatarsals, with their respective digits, are compared together.

The same two classes of differences become obvious when the muscles of the hand are compared with those of the foot.

Three principal sets of muscles, called "flexors," bend the fingers and the thumb, as in clenching the fist, and three sets,— the extensors — extend them, as in straightening the fingers. These muscles are all "long muscles"; that is to say, the fleshy part of each, lying in and being fixed to the bones of the arm, is, at the other end, continued into tendons, or rounded cords, which pass into the hand, and are ultimately fixed to the bones which are to be moved. Thus, when the fingers are bent, the fleshy parts of the flexors of the fingers, placed in the arm, contract, in virtue of their peculiar endowment as muscles; and pulling the tendinous cords, connecting with their ends, cause them to pull down the bones of the fingers towards the palm.

Not only are the principal flexors of the fingers and of the

thumb long muscles, but they remain quite distinct from one another throughout their whole length.

In the foot, there are also three principal flexor muscles of the digits or toes, and three principal extensors; but one extensor and one flexor are short muscles; that is to say, their fleshy parts are not situated in the leg (which corresponds with the arm), but in the back and in the sole of the foot — regions which correspond with the back and the palm of the hand.

Again, the tendons of the long flexor of the toes, and of the long flexor of the great toe, when they reach the sole of the foot, do not remain distinct from one another, as the flexors in the palm of the hand do, but they become united and commingled in a very curious manner — while their united tendons receive an accessory muscle connected with the heel-bone.

But perhaps the most absolutely distinctive character about the muscles of the foot is the existence of what is termed the *peronæus longus*, a long muscle fixed to the outer bone of the leg, and sending its tendon to the outer ankle, behind and below which it passes, and then crosses the foot obliquely to be attached to the base of the great toe. No muscle in the hand exactly corresponds with this, which is eminently a foot muscle.

To resume — the foot of man is distinguished from his hand by the following absolute anatomical differences —

1. By the arrangement of the tarsal bones.
2. By having a short flexor and a short extensor muscle of the digits.
3. By possessing the muscle termed *peronæus longus*.

And if we desire to ascertain whether the terminal division of a limb, in other Primates, is to be called a foot or a hand, it is by the presence or absence of these characters that we must be guided, and not by the mere proportions and greater or lesser mobility of the great toe, which may vary indefinitely without any fundamental alteration in the structure of the foot.

Keeping these considerations in mind, let us now turn to the limbs of the Gorilla. The terminal division of the fore limb presents no difficulty — bone for bone and muscle for muscle, are found to be arranged essentially as in man, or with such minor differences as are found as varieties in man. The Gorilla's hand is clumsier, heavier, and has a thumb somewhat shorter in proportion than that of man; but no one has ever doubted it being a true hand.

At first sight, the termination of the hind limb of the Gorilla looks very hand-like, and as it is still more so in many of the

lower apes, it is not wonderful that the appellation "Quadrumana," or four-handed creatures, adopted from the older anatomists* by Blumenbach, and unfortunately rendered current by Cuvier, should have gained such wide acceptance as a name for the Simian group. But the most cursory anatomical investigation at once proves that the resemblance of the so-called "hind-hand" to a true hand, is only skin deep, and that, in all essential respects, the hind limb of the Gorilla is as truly terminated by a foot as that of man. The tarsal bones, in all important circumstances of number, disposition, and form, resemble those of man (Fig. 20). The metatarsals and digits, on the other hand, are proportionally longer and more slender, while the great toe is not only proportionally shorter and weaker, but its metatarsal bone is united by a more movable joint with the tarsus. At the same time, the foot is set more obliquely upon the leg than in man.

As to the muscles, there is a short flexor, a short extensor, and a *peronæus longus*, while the tendons of the long flexors of the great toe and of the other toes are united together and with an accessory fleshy bundle.

The hind limb of the Gorilla, therefore, ends in a true foot, with a very movable great toe. It is a prehensile foot, indeed, but is in no sense a hand; it is a foot which differs from that of man not in any fundamental character, but in mere proportions, in the degree of mobility, and in the secondary arrangement of its parts.

It must not be supposed, however, because I speak of these differences as not fundamental, that I wish to underrate their value. They are important enough in their way, the structure of the foot being in strict correlation with that of the rest of the organism in each case. Nor can it be doubted that the greater division of physiological labour in Man, so that the function of support is thrown wholly on the leg and foot, is an advance in organization of very great moment to him; but, after all, regarded anatomically, the resemblances between the foot of Man

* In speaking of the foot of his "Pygmie," Tyson remarks, p. 13:—
"But this part in the formation and in its function too, being liker a Hand than a Foot: for the distinguishing sort of animals from others, I have thought whether it might not be reckoned and called rather Quadru-manus than Quadrupes, *i. e.* a four-handed rather than a four-footed animal."
As this passage was published in 1699, M. I. G. St. Hilaire is clearly in error in ascribing the invention of the term "quadrumanous" to Buffon, though "bimanous" may belong to him. Tyson uses "Quadrumanus" in several places, as at p. 91. . . . "Our *Pygmie* is no Man, nor yet the *common Ape*, but a sort of *Animal* between both; and though a *Biped*, yet of the *Quadrumanus*-kind: though some *Men* too have been observed to use their *Feet* like *Hands* as I have seen several."

and the foot of the Gorilla are far more striking and important than the differences.

I have dwelt upon this point at length, because it is one regarding which much delusion prevails; but I might have passed it over without detriment to my argument, which only requires me to show that, be the differences between the hand and foot of Man and those of the Gorilla what they may — the differences between those of the Gorilla, and those of the lower Apes are much greater.

It is not necessary to descend lower in the scale than the Orang for conclusive evidence on this head.

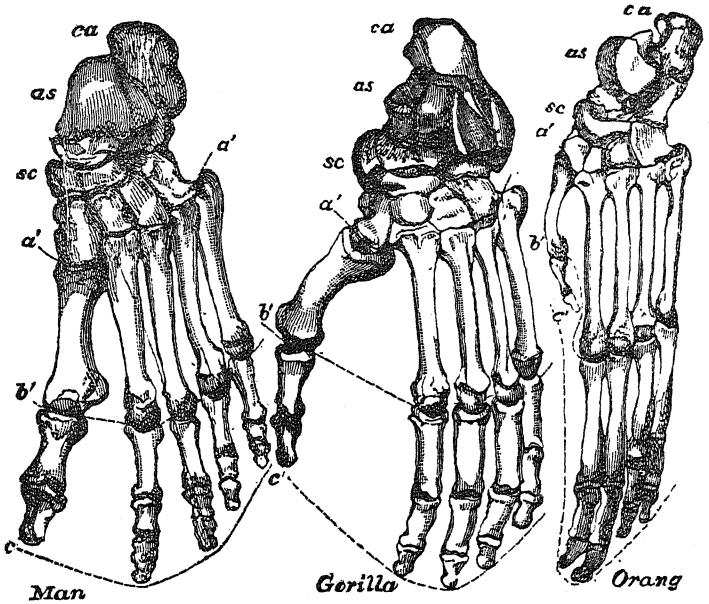


Fig. 20.—Foot of Man, Gorilla, and Orang-Utan of the same absolute length, to show the differences in proportion of each. Letters as in Fig. 19. Reduced from original drawings by Mr. Waterhouse Hawkins.

The thumb of the Orang differs more from that of the Gorilla than the thumb of the Gorilla differs from that of Man, not only by its shortness, but by the absence of any special long flexor muscle. The carpus of the Orang, like that of most lower apes, contains nine bones, while in the Gorilla, as in Man, and the Chimpanzee, there are only eight.

The Orang's foot (Fig. 20) is still more aberrant; its very long toes and short tarsus, short great toe, short and raised heel, great

obliquity of articulation with the leg, and absence of a long flexor tendon to the great toe, separating it far more widely from the foot of the Gorilla than the latter is separated from that of Man.

But, in some of the lower apes, the hand and foot diverge still more from those of the Gorilla, than they do in the Orang. The thumb ceases to be opposable in the American monkeys; is reduced to a mere rudiment covered by the skin in the Spider Monkey; and is directed forwards and armed with a curved claw like the other digits, in the Marmosets — so that, in all these cases, there can be no doubt but that the hand is more different from that of the Gorilla than the Gorilla's hand is from Man's.

And as to the foot, the great toe of the Marmoset is still more insignificant in proportion than that of the Orang — while in the Lemurs it is very large, and as completely thumb-like and opposable as in the Gorilla — but in these animals the second toe is often irregularly modified, and in some species the two principal bones of the tarsus, the *astragalus* and the *os calcis*, are so immensely elongated as to render the foot, so far, totally unlike that of any other mammal.

So with regard to the muscles. The short flexor of the toes of the Gorilla differs from that of Man by the circumstance that one slip of the muscle is attached, not to the heel bone, but to the tendons of the long flexors. The lower Apes depart from the Gorilla by an exaggeration of the same character, two, three, or more slips becoming fixed to the long flexor tendons — or by a multiplication of the slips.— Again, the Gorilla differs slightly from Man in the mode of interlacing of the long flexor tendons: and the lower apes differ from the Gorilla in exhibiting yet other, sometimes very complex, arrangements of the same parts, and occasionally in the absence of the accessory fleshy bundle.

Throughout all these modifications it must be recollected that the foot loses no one of its essential characters. Every Monkey and Lemur exhibits the characteristic arrangement of tarsal bones, possesses a short flexor and short extensor muscle, and a *peronæus longus*. Varied as the proportions and appearance of the organ may be, the terminal division of the hind limb remains, in plan and principle of construction, a foot, and never, in those respects, can be confounded with a hand.

Hardly any part of the bodily frame, then, could be found better calculated to illustrate the truth that the structural differences between Man and the highest Ape are of less value than those between the highest and the lower Apes, than the hand or the foot; and yet, perhaps, there is one organ the study of which

enforces the same conclusion in a still more striking manner — and that is the Brain.

But before entering upon the precise question of the amount of difference between the Ape's brain and that of Man, it is necessary that we should clearly understand what constitutes a great, and what a small difference in cerebral structure; and we shall be best enabled to do this by a brief study of the chief modifications which the brain exhibits in the series of vertebrate animals.

The brain of a fish is very small, compared with the spinal cord into which it is continued, and with the nerves which come off from it: of the segments of which it is composed — the olfactory lobes, the cerebral hemispheres, and the succeeding divisions — no one predominates so much over the rest as to obscure or cover them; and the so-called optic lobes are, frequently, the largest masses of all. In Reptiles, the mass of the brain, relatively to the spinal cord, increases and the cerebral hemispheres begin to predominate over the other parts; while in Birds this predominance is still more marked. The brain of the lowest Mammals, such as the duck-billed Platypus and the Opossums and Kangaroos, exhibits a still more definite advance in the same direction. The cerebral hemispheres have now so much increased in size as, more or less, to hide the representatives of the optic lobes, which remain comparatively small, so that the brain of a Marsupial is extremely different from that of a Bird, Reptile, or Fish. A step higher in the scale, among the placental Mammals, the structure of the brain requires a vast modification — not that it appears much altered externally, in a Rat or in a Rabbit, from what it is in a Marsupial — nor that the proportions of its parts are much changed, but an apparently new structure is found between the cerebral hemispheres, connecting them together, at what is called the "great commissure" or "corpus callosum." The subject requires careful re-investigation, but if the currently received statements are correct, the appearance of the "corpus callosum" in the placental mammals is the greatest and most sudden modification exhibited by the brain in the whole series of vertebrated animals — it is the greatest leap anywhere made by Nature in her brain work. For the two halves of the brain being once thus knit together, the progress of cerebral complexity is traceable through a complete series of steps from the lowest Rodent, or Insectivore, to Man; and that complexity consists, chiefly, in the disproportionate development of the cerebral hemispheres and of the cerebellum, but especially of the former, in respect to the other parts of the brain.

In the lower placental mammals, the cerebral hemispheres leave the proper upper and posterior face of the cerebellum completely visible, when the brain is viewed from above; but, in the higher forms, the hinder part of each hemisphere, separated only by the tentorium (p. 78) from the anterior face of the cerebellum, inclines backwards and downwards, and grows out, as the so-called "posterior lobe," so as at length to overlap and hide the cerebellum. In all Mammals, each cerebral hemisphere contains a cavity which is termed the "ventricle"; and as this ventricle is prolonged, on the one hand, forwards, and on the other downwards, into the substance of the hemisphere, it is said to have two horns or "cornua," an "anterior cornu," and a "descending cornu." When the posterior lobe is well developed, a third prolongation of the ventricular cavity extends into it, and is called the "posterior cornu."

In the lower and smaller forms of placental Mammals the surface of the cerebral hemispheres is either smooth or evenly rounded, or exhibits a very few grooves, which are technically termed "sulci," separating ridges or "convolutions" of the substance of the brain; and the smaller species of all orders tend to a similar smoothness of brain. But, in the higher orders, and especially the larger members of these orders, the grooves, or sulci, become extremely numerous, and the intermediate convolutions proportionately more complicated in their meanderings, until, in the Elephant, the Porpoise, the higher Apes, and Man, the cerebral surface appears a perfect labyrinth of tortuous foldings.

Where a posterior lobe exists and presents its customary cavity — the posterior cornu — it commonly happens that a particular sulcus appears upon the inner and under surface of the lobe, parallel with and beneath the floor of the cornu — which is, as it were, arched over the roof of the sulcus. It is as if the groove had been formed by indenting the floor of the posterior horn from without with a blunt instrument, so that the floor should rise as a convex eminence. Now this eminence is what has been termed the "Hippocampus minor"; the "Hippocampus major" being a larger eminence in the floor of the descending cornu. What may be the functional importance of either of these structures we know not.

As if to demonstrate, by a striking example, the impossibility of erecting any cerebral barrier between man and the apes, Nature has provided us, in the latter animals, with an almost complete series of gradations from brains little higher than that of a Rodent, to brains little lower than that of Man. And it is a re-

markable circumstance, that though so far as our present knowledge extends, there *is* one true structural break in the series of forms of Simian brains, this hiatus does not lie between Man and the man-like apes, but between the lower and the lowest Simians; or, in other words, between the old and new world apes and monkeys, and the Lemurs. Every Lemur which has yet been examined, in fact, has its cerebellum partially visible from above, and its posterior lobe, with the contained posterior cornu and hippocampus minor, more or less rudimentary. Every Marmoset, American monkey, old world monkey, Baboon, or Man-like ape, on the contrary, has its cerebellum entirely hidden, posteriorly, by the cerebral lobes, and possesses a large posterior cornu, with a well-developed hippocampus minor.

In many of these creatures, such as the Saimiri (*Chrysothrix*), the cerebral lobes overlap and extend much further behind the cerebellum, in proportion, than they do in man (Fig. 17) — and it is quite certain that, in all, the cerebellum is completely covered behind, by well developed posterior lobes. The fact can be verified by every one who possesses the skull of any old or new world monkey. For, inasmuch as the brain in all mammals completely fills the cranial cavity, it is obvious that a cast of the interior of the skull will reproduce the general form of the brain, at any rate with such minute and, for the present purpose, utterly unimportant differences as may result from the absence of the enveloping membranes of the brain in the dry skull. But if such a cast be made in plaster, and compared with a similar cast of the interior of a human skull, it will be obvious that the cast of the cerebral chamber, representing the cerebrum of the ape, as completely covers over and overlaps the cast of the cerebellar chamber, representing the cerebellum, as it does in the man (Fig. 21). A careless observer, forgetting that a soft structure like the brain loses its proper shape the moment it is taken out of the skull, may indeed mistake the uncovered condition of the cerebellum of an extracted and distorted brain for the natural relations of the parts; but his error must become patent even to himself if he try to replace the brain within the cranial chamber. To suppose that the cerebellum of an ape is naturally uncovered behind is a miscomprehension comparable only to that of one who should imagine that a man's lungs always occupy but a small portion of the thoracic cavity, because they do so when the chest is opened, and their elasticity is no longer neutralized by the pressure of the air.

And the error is the less excusable, as it must become apparent to every one who examines a section of the skull of any ape

above a Lemur, without taking the trouble to make a cast of it. For there is a very marked groove in every such skull, as in the human skull — which indicates the line of attachment of what is

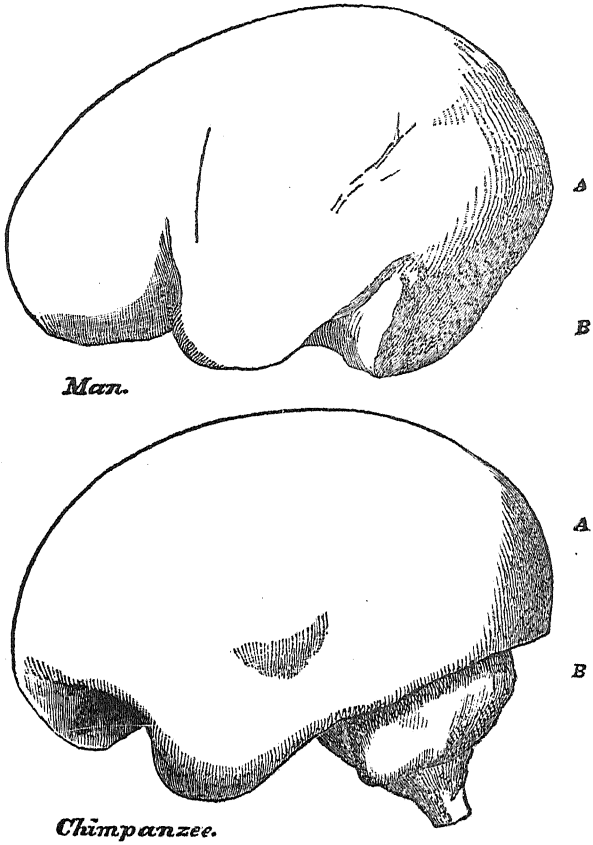


Fig. 21.—Drawings of the internal casts of a Man's and of a Chimpanzee's skull, of the same absolute length, and placed in corresponding positions, *A*. Cerebrum; *B*. Cerebellum. The former drawing is taken from a cast in the Museum of the Royal College of Surgeons, the latter from the photograph of the cast of a Chimpanzee's skull, which illustrates the paper by Mr. Marshall "On the Brain of the Chimpanzee" in the *Natural History Review* for July, 1861. The sharper definition of the lower edge of the cast of the cerebral chamber in the Chimpanzee arises from the circumstance that the tentorium remained in that skull and not in the Man's. The cast more accurately represents the brain in the Chimpanzee than in the Man; and the great backward projection of the posterior lobes of the cerebrum of the former, beyond the cerebellum, is conspicuous.

termed the *tentorium* — a sort of parchment-like shelf, or partition, which, in the recent state, is interposed between the cerebrum and cerebellum, and prevents the former from pressing upon the latter. (See Fig. 17.)

This groove, therefore, indicates the line of separation between that part of the cranial cavity which contains the cerebrum, and that which contains the cerebellum; and as the brain exactly fills the cavity of the skull, it is obvious that the relations of these two parts of the cranial cavity at once informs us of the relations of their contents. Now in man, in all the old world, and in all the new world Simiæ, with one exception, when the face is directed forwards, this line of attachment of the tentorium, or impression for the lateral sinus, as it is technically called, is nearly horizontal, and the cerebral chamber invariably overlaps or projects behind the cerebellar chamber. In the Howler Monkey or *Mycetes* (see Fig. 17), the line passes obliquely upwards and backwards, and the cerebral overlap is almost nil; while in the Lemurs, as in the lower mammals, the line is much more inclined in the same direction, and the cerebellar chamber projects considerably beyond the cerebral.

When the gravest errors respecting points so easily settled as this question respecting the posterior lobes, can be authoritatively propounded, it is no wonder that matters of observation, of no very complex character, but still requiring a certain amount of care, should have fared worse. Any one who cannot see the posterior lobe in an ape's brain is not likely to give a very valuable opinion respecting the posterior cornu or the hippocampus minor. If a man cannot see a church, it is preposterous to take his opinion about its altar-piece or painted window — so that I do not feel bound to enter upon any discussion of these points, but content myself with assuring the reader that the posterior cornu and the hippocampus minor, have now been seen — usually, at least as well developed as in man, and often better — not only in the Chimpanzee, the Orang, and the Gibbon, but in all the genera of the old world baboons and monkeys, and in most of the new world forms, including the Marmosets.

In fact, all the abundant and trustworthy evidence (consisting of the results of careful investigations directed to the determination of these very questions, by skilled anatomists) which we now possess, leads to the conviction that, so far from the posterior lobe, the posterior cornu, and the hippocampus minor, being structures peculiar to and characteristic of man, as they have been over and over again asserted to be, even after the publication of the clearest demonstration of the reverse, it is precisely these structures which

are the most marked cerebral characters common to man with the apes. They are among the most distinctly Simian peculiarities which the human organism exhibits.

As to the convolutions the brains of the apes exhibit every stage of progress, from the almost smooth brain of the Marmoset, to the Orang and the Chimpanzee, which fall but little below Man. And it is most remarkable that, as soon as all the principal sulci appear, the pattern according to which they are arranged is identical with that of the corresponding sulci of man. The surface of the brain of a monkey exhibits a sort of skeleton map of man's, and in the man-like apes the details become more and more filled in, until it is only in minor characters, such as the greater excavation of the anterior lobes, the constant presence of fissures usually absent in man, and the different disposition and proportions of some convolutions, that the Chimpanzee's or the Orang's brain can be structurally distinguished from Man's.

So far as cerebral structure goes, therefore, it is clear that Man differs less from the Chimpanzee or the Orang, than these do even from the monkeys, and that the difference between the brains of the Chimpanzee and of Man is almost insignificant, when compared with that between the Chimpanzee brain and that of a Lemur.

It must not be overlooked, however, that there is a very striking difference in absolute mass and weight between the lowest human brain and that of the highest ape — a difference which is all the more remarkable when we recollect that a full-grown Gorilla is pretty nearly twice as heavy as a Bosjesman, or as many an European woman. It may be doubted whether a healthy human adult brain ever weighed less than thirty-one or two ounces, or that the heaviest Gorilla brain has exceeded twenty ounces.

This is a very noteworthy circumstance, and doubtless will one day help to furnish an explanation of the great gulf which intervenes between the lowest man and the highest ape in intellectual power;* but it has little systematic value, for the simple

* I say *help* to furnish: for I by no means believe that it was any original difference of cerebral quality, or quantity, which caused that divergence between the human and the pithecoid stirpes, which has ended in the present enormous gulf between them. It is no doubt perfectly true, in a certain sense, that all difference of function is a result of difference of structure; or, in other words, of difference in the combination of the primary molecular forces of living substance; and, starting from this undeniable axiom, objectors occasionally, and with much seeming plausibility, argue that the vast intellectual chasm between the Ape and Man implies a corresponding structural chasm in the organs of the intellectual functions; so that, it is said, the non-discovery of such vast differences proves, not that they are absent, but that Science is incompetent to detect them. A very little consideration, however, will, I think, show the fallacy of this reasoning. Its validity hangs upon the assump-

reason that, as may be concluded from what has been already said respecting cranial capacity, the difference in weight of brain between the highest and the lowest men is far greater, both relatively and absolutely, than that between the lowest man and the highest ape. The latter, as has been seen, is represented by, say twelve, ounces of cerebral substance absolutely or by 32:20 relatively; but as the largest recorded human brain weighed between 65 and 66 ounces, the former difference is represented by more than 33 ounces absolutely, or by 65:32 relatively. Regarded systematically, the cerebral differences of man and apes are not of more than generic value; his Family distinction resting chiefly on his dentition, his pelvis, and his lower limbs.

Thus, whatever system of organs be studied, the comparison of their modifications in the ape series leads to one and the same result — that the structural differences which separate Man from the Gorilla and the Chimpanzee are not so great as those which separate the Gorilla from the lower apes.

But in enunciating this important truth I must guard myself against a form of misunderstanding, which is very prevalent. I find, in fact, that those who endeavour to teach what nature so clearly shows us in this matter, are liable to have their opinions

tion, that intellectual power depends altogether on the brain — whereas the brain is only one condition out of many on which intellectual manifestations depend; the others being, chiefly, the organs of the senses and the motor apparatuses, especially those which are concerned in prehension and in the production of articulate speech.

A man born dumb, notwithstanding his great cerebral mass and his inheritance of strong intellectual instincts, would be capable of few higher intellectual manifestations than an Orang or a Chimpanzee, if he were confined to the society of dumb associates. And yet there might not be the slightest discernible difference between his brain and that of a highly intelligent and cultivated person. The dumbness might be the result of a defective innervation of these parts; or it might result from congenital deafness, caused by some minute defect of the internal ear, which only a careful anatomist could discover.

The argument, that because there is an immense difference between a Man's intelligence and an Ape's, therefore, there must be an equally immense difference between their brains, appears to me to be about as well based as the reasoning by which one should endeavor to prove that, because there is a "great gulf" between a watch that keeps accurate time and another that will not go at all, there is therefore a great structural hiatus between the two watches. A hair in the balance-wheel, a little rust on a pinion, a bend in a tooth of the escapement, a something so slight that only the practised eye of the watchmaker can discover it, may be the source of all the difference.

And believing, as I do, with Cuvier, that the possession of articulate speech is the grand distinctive character of man (whether it be absolutely peculiar to him or not), I find it very easy to comprehend, that some equally inconspicuous structural difference may have been the primary cause of the immeasurable and practically infinite divergence of the Human from the Simian Stirps.

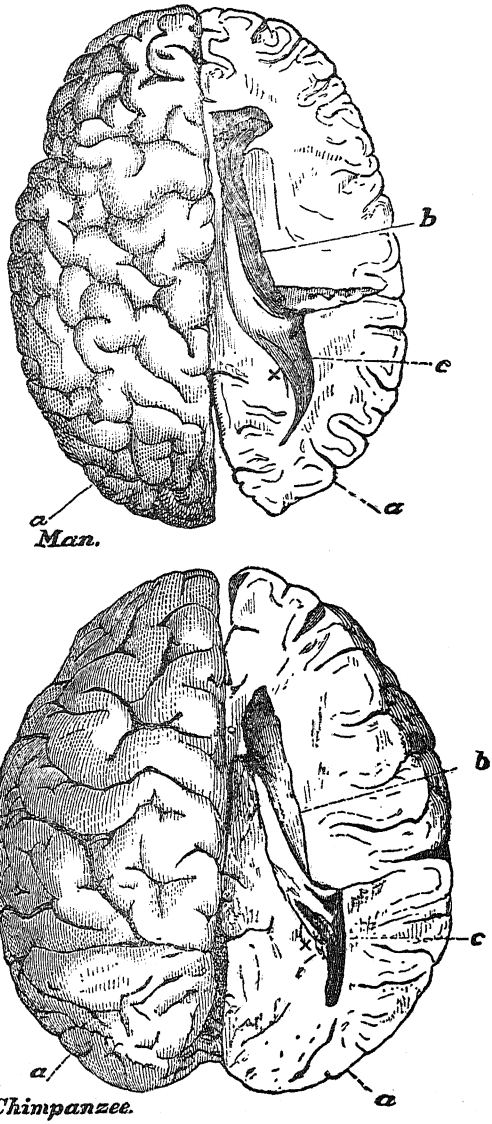


Fig. 22.—Drawing of the cerebral hemispheres of a Man, and of a Chimpanzee of the same length, in order to show the relative proportions of the parts: the former taken from a specimen, which Mr. Flower,

Conservator of the Museum of the Royal College of Surgeons, was good enough to dissect for me; the latter, from the photograph of a similarly dissected Chimpanzee's brain, given in Mr. Marshall's paper above referred to. *a*, posterior lobe; *b*, lateral ventricle; *c*, posterior cornu; *x*, the hippocampus minor.

misrepresented and their phraseology garbled, until they seem to say that the structural differences between man and even the highest apes are small and insignificant. Let me take this opportunity then of distinctly asserting, on the contrary, that they are great and significant; that every bone of a Gorilla bears marks by which it might be distinguished from the corresponding bone of a Man; and that, in the present creation, at any rate, no intermediate link bridges over the gap between *Homo* and *Troglodytes*.

It would be no less wrong than absurd to deny the existence of this chasm; but it is at least equally wrong and absurd to exaggerate its magnitude and, resting on the admitted fact of its existence, to refuse to inquire whether it is wide or narrow. Remember, if you will, that there is no existing link between Man and the Gorilla, but do not forget that there is a no less sharp line of demarcation, a no less complete absence of any transitional form, between the Gorilla and the Orang, or the Orang and the Gibbon. I say, not less sharp, though it is somewhat narrower. The structural differences between Man and the Man-like apes certainly justify our regarding him as constituting a family apart from them; though, inasmuch as he differs less from them than they do from other families of the same order, there can be no justification for placing him in a distinct order.

And thus the sagacious foresight of the great lawgiver of systematic zoology, Linnæus, becomes justified, and a century of anatomical research brings us back to his conclusion, that man is a member of the same order (for which the Linnæan term PRIMATES ought to be retained) as the Apes and Lemurs. This order is now divisible into seven families, of about equal systematic value: the first, the ANTHROPINI, contains Man alone; the second, the CATARHINI, embraces the old world apes; the third, the PLATYRHINI, all new world apes, except the Marmosets; the fourth, the AROTOPITHECINI, contains the Marmosets; the fifth, the LEMURINI, the Lemurs — from which *Cheiromys* should probably be excluded to form a sixth distinct family, the CHEIROMYINI; while the seventh, the GALEOPITHECINI, contains only the flying Lemur *Galeopithecus*,— a strange form which almost touches on the Bats, as the *Cheiromys* puts on a Rodent clothing, and the Lemurs simulate Insectivora.

Perhaps no order of mammals presents us with so extraordinary a series of gradations as this — leading us insensibly from the crown and summit of the animal creation down to creatures, from which there is but a step, as it seems, to the lowest, smallest, and least intelligent of the placental Mammalia. It is as if nature herself had foreseen the arrogance of man, and with Roman severity had provided that his intellect, by its very triumphs, should call into prominence the slaves, admonishing the conqueror that he is but dust.

These are the chief facts, this the immediate conclusion from them to which I adverted in the commencement of this Essay. The facts, I believe, cannot be disputed; and if so, the conclusion appears to me to be inevitable.

But if Man be separated by no greater structural barrier from the brutes than they are from one another — then it seems to follow that if any process of physical causation can be discovered by which the genera and families of ordinary animals have been produced, that process of causation is amply sufficient to account for the origin of Man. In other words, if it could be shown that the Marmosets, for example, have arisen by gradual modification of the ordinary Platyrhini, or that both Marmosets and Platyrhini are modified ramifications of a primitive stock — then, there would be no rational ground for doubting that man might have originated, in the one case, by the gradual modification of a man-like ape; or, in the other case, as a ramification of the same primitive stock as those apes.

At the present moment, but one such process of physical causation has any evidence in its favour; or, in other words, there is but one hypothesis regarding the origin of species of animals in general which has any scientific existence — that propounded by Mr. Darwin. For Lamarck, sagacious as many of his views were, mingled them with so much that was crude and even absurd, as to neutralize the benefit which his originality might have effected, had he been a more sober and cautious thinker; and though I have heard of the announcement of a formula touching "the ordained continuous becoming of organic forms," it is obvious that it is the first duty of a hypothesis to be intelligible, and that a qua-quâ-versal proposition of this kind, which may be read backwards, or forwards, or sideways, with exactly the same amount of signification, does not really exist, though it may seem to do so.

At the present moment, therefore, the question of the relation of man to the lower animals resolves itself, in the end, into the larger question of the tenability, or untenability, of Mr. Darwin's

views. But here we enter upon difficult ground, and it behoves us to define our exact position with the greatest care.

It cannot be doubted, I think, that Mr. Darwin has satisfactorily proved that what he terms selection, or selective modification, must occur, and does occur, in nature; and he has also proved to superfluity that such selection is competent to produce forms as distinct, structurally, as some genera even are. If the animated world presented us with none but structural differences, I should have no hesitation in saying that Mr. Darwin had demonstrated the existence of a true physical cause, amply competent to account for the origin of living species, and of man among the rest.

But, in addition to their structural distinctions, the species of animals and plants, or at least a great number of them, exhibit physiological characters — what are known as distinct species, structurally, being for the most part either altogether incompetent to breed one with another; or if they breed, the resulting mule, or hybrid, is unable to perpetuate its race with another hybrid of the same kind.

A true physical cause is, however, admitted to be such only on one condition — that it shall account for all the phenomena which come within the range of its operation. If it is inconsistent with any one phenomenon, it must be rejected; if it fails to explain any one phenomenon, it is so far weak, so far to be suspected; though it may have a perfect right to claim provisional acceptance.

Now, Mr. Darwin's hypothesis is not, so far as I am aware, inconsistent with any known biological fact; on the contrary, if admitted, the facts of Development, of Comparative Anatomy, of Geographical Distribution, and of Palæontology, become connected together, and exhibit a meaning such as they never possessed before; and I, for one, am fully convinced, that if not precisely true, that hypothesis is as near an approximation to the truth as, for example, the Copernican hypothesis was to the true theory of the planetary motions.

But, for all this, our acceptance of the Darwinian hypothesis must be provisional so long as one link in the chain of evidence is wanting; and so long as all the animals and plants certainly produced by selective breeding from a common stock are fertile, and their progeny are fertile with one another, that link will be wanting. For, so long, selective breeding will not be proved to be competent to do all that is required of it to produce natural species.

I have put this conclusion as strongly as possible before the

reader, because the last position in which I wish to find myself is that of an advocate for Mr. Darwin's, or any other views; if by an advocate is meant one whose business it is to smooth over real difficulties, and to persuade where he cannot convince.

In justice to Mr. Darwin, however, it must be admitted that the conditions of fertility and sterility are very ill understood, and that every day's advance in knowledge leads us to regard the hiatus in his evidence as of less and less importance, when set against the multitude of facts which harmonize with, or receive an explanation from, his doctrines.

I adopt Mr. Darwin's hypothesis, therefore, subject to the production of proof that physiological species may be produced by selective breeding; just as a physical philosopher may accept the undulatory theory of light, subject to the proof of the existence of the hypothetical ether; or as the chemist adopts the atomic theory, subject to the proof of the existence of atoms; and for exactly the same reasons, namely, that it has an immense amount of primâ facie probability; that it is the only means at present within reach of reducing the chaos of observed facts to order; and lastly, that it is the most powerful instrument of investigation which has been presented to naturalists since the invention of the natural system of classification, and the commencement of the systematic study of embryology.

But even leaving Mr. Darwin's view aside, the whole analogy of natural operations furnishes so complete and crushing an argument against the intervention of any but what are termed secondary causes, in the production of all the phenomena of the universe; that, in view of the intimate relations between Man and the rest of the living world, and between the forces exerted by the latter and all other forces, I can see no excuse for doubting that all are co-ordinated terms of Nature's great progression, from the formless to the formed — from the inorganic to the organic — from blind force to conscious intellect and will.

Science has fulfilled her function when she has ascertained and enunciated truth; and were these pages addressed to men of science only, I should now close this Essay, knowing that my colleagues have learned to respect nothing but evidence, and to believe that their highest duty lies in submitting to it, however it may jar against their inclinations.

But, desiring, as I do, to reach the wider circle of the intelligent public, it would be unworthy cowardice were I to ignore the repugnance with which the majority of my readers are likely to

meet the conclusions to which the most careful and conscientious study I have been able to give to this matter, has led me.

On all sides I shall hear the cry — "We are men and women, not a mere better sort of apes, a little longer in the leg, more compact in the foot, and bigger in brain than your brutal Chimpanzees and Gorillas. The power of knowledge — the conscience of good and evil — the pitiful tenderness of human affections, raise us out of all real fellowship with the brutes, however closely they may seem to approximate us."

To this I can only reply that the exclamation would be most just and would have my own entire sympathy, if it were only relevant. But, it is not I who seek to base Man's dignity upon his great toe, or insinuate that we are lost if an Ape has a hippocampus minor. On the contrary, I have done my best to sweep away this vanity. I have endeavoured to show that no absolute structural line of demarcation, wider than that between the animals which immediately succeed us in the scale, can be drawn between the animal world and ourselves; and I may add the expression of my belief that the attempt to draw a psychical distinction is equally futile, and that even the highest faculties of feeling and of intellect begin to germinate in lower forms of life.* At the same time, no one is more strongly convinced than I am of the vastness of the gulf between civilized man and the brutes; or is more certain that whether *from* them or not, he is assuredly not *of* them. No one is less disposed to think likely of the present dignity, or despairingly of the future hopes of the only consciously intelligent denizen of this world.

We are indeed told by those who assume authority in these matters, that the two sets of opinions are incompatible, and that the belief in the unity of origin of man and brutes involves the

* It is so rare a pleasure for me to find Professor Owen's opinions in entire accordance with my own, that I cannot forbear from quoting a paragraph which appeared in his Essay "On the Characters, &c., of the Class Mammalia," in the *Journal of the Proceedings of the Linnean Society of London* for 1857, but is unaccountably omitted in the "Reade Lecture" delivered before the University of Cambridge two years later, which is otherwise nearly a reprint of the paper in question. Prof. Owen writes:

"Not being able to appreciate or conceive of the distinction between the psychical phenomena of a Chimpanzee and of a Boschisman or of an Aztec, with arrested brain growth, as being of a nature so essential as to preclude a comparison between them, or as being other than a difference of degree, I cannot shut my eyes to the significance of that all-pervading similitude of structure—every tooth, every bone, strictly homologous — which makes the determination of the difference between *Homo* and *Pithecus* the anatomist's difficulty."

Surely it is a little singular, that the "anatomist," who finds it "difficult" to determine "the difference" between *Homo* and *Pithecus*, should yet range them on anatomical grounds, in distinct sub-classes.

brutalization and degradation of the former. But is this really so? Could not a sensible child confute by obvious arguments, the shallow rhetoricians who would force this conclusion upon us? Is it, indeed, true, that the Poet, or the Philosopher, or the Artist whose genius is the glory of his age, is degraded from his high estate by the undoubted historical probability, not to say certainty, that he is the direct descendant of some naked and bestial savage, whose intelligence was just sufficient to make him a little more cunning than the Fox, and by so much more dangerous than the Tiger? Or is he bound to howl and grovel on all fours because of the wholly unquestionable fact, that he was once an egg, which no ordinary power of discrimination could distinguish from that of a Dog? Or is the philanthropist, or the saint, to give up his endeavours to lead a noble life, because the simplest study of man's nature reveals, at its foundations, all the selfish passions, and fierce appetites of the merest quadruped? Is mother-love vile because a hen shows it, or fidelity base because dogs possess it?

The common sense of the mass of mankind will answer these questions without a moment's hesitation. Healthy humanity, finding itself hard pressed to escape from real sin and degradation, will leave the brooding over speculative pollution to the cynics and the "righteous overmuch" who, disagreeing in everything else, unite in blind insensibility to the nobleness of the visible world, and in inability to appreciate the grandeur of the place Man occupies therein.

Nay more, thoughtful men, once escaped from the blinding influences of traditional prejudice, will find in the lowly stock whence Man has sprung, the best evidence of the splendour of his capacities; and will discern in his long progress through the Past, a reasonable ground of faith in his attainment of a nobler Future.

They will remember that in comparing civilised man with the animal world, one is as the Alpine traveller, who sees the mountains soaring into the sky and can hardly discern where the deep shadowed crags and roseate peaks end, and where the clouds of heaven begin. Surely the awestruck voyager may be excused if, at first, he refuses to believe the geologist, who tells him that these glorious masses are, after all, the hardened mud of primeval seas, or the cooled slag of subterranean furnaces — of one substance with the dullest clay, but raised by inward forces to that place of proud and seemingly inaccessible glory.

But the geologist is right; and due reflection on his teachings, instead of diminishing our reverence and our wonder, adds all

the force of intellectual sublimity to the mere æsthetic intuition of the uninstructed beholder.

And after passion and prejudice have died away, the same result will attend the teachings of the naturalist respecting that great Alps and Andes of the living world — Man. Our reverence for the nobility of manhood will not be lessened by the knowledge that Man is, in substance and in structure, one with the brutes; for, he alone possesses the marvellous endowment of intelligible and rational speech, whereby, in the secular period of his existence, he has slowly accumulated and organised the experience which is almost wholly lost with the cessation of every individual life in other animals; so that, now, he stands raised upon it as on a mountain top, far above the level of his humble fellows, and transfigured from his grosser nature by reflecting, here and there, a ray from the infinite source of truth.

III.

ON SOME FOSSIL REMAINS OF MAN.

I HAVE endeavored to show, in the preceding Essay, that the ANTHROPINI, or Man Family, form a very well-defined group of the Primates, between which and the immediately following Family, the CATARHINI, there is, in the existing world, the same entire absence of any transitional form or connecting link, as between the CATARHINI and PLATYRHINI.

It is a commonly received doctrine, however, that the structural intervals between the various existing modifications of organic beings may be diminished, or even obliterated, if we take into account the long and varied succession of animals and plants which have preceded these now living and which are known to us only by their fossilized remains. How far this doctrine is well based, how far, on the other hand, as our knowledge at present stands, it is an overstatement of the real facts of the case, and an exaggeration of the conclusions fairly deducible from them, are points of grave importance, but into the discussion of which I do not, at present, propose to enter. It is enough that such a view of the relations of extinct to living beings has been propounded, to lead us to inquire, with anxiety, how far the recent discoveries of human remains in a fossil state bear out, or oppose, that view.

I shall confine myself, in discussing this question, to those fragmentary Human skulls from the caves of Engis in the valley of the Meuse, in Belgium, and of the Neanderthal, near Düsseldorf, the geological relations of which have been examined with so much care by Sir Charles Lyell; upon whose high authority I shall take it for granted, that the Engis skull belonged to a contemporary of the Mammoth (*Elephas primigenius*) and of the woolly Rhinoceros (*Rhinoceros tichorhinus*), with the bones of which it was found associated; and that the Neanderthal skull is of great, though uncertain, antiquity. Whatever be the geological age of the latter skull, I conceive it is quite safe (on the ordinary principles of paleontological reasoning) to assume that the former

takes us to, at least, the further side of the vague biological limit, which separates the present geological epoch from that which immediately preceded it. And there can be no doubt that the physical geography of Europe has changed wonderfully, since the bones of Men and Mammoths, Hyænas and Rhinoceroses were washed pell-mell into the cave of Engis.

The skull from the cave of Engis was originally discovered by Professor Schmerling, and was described by him, together with

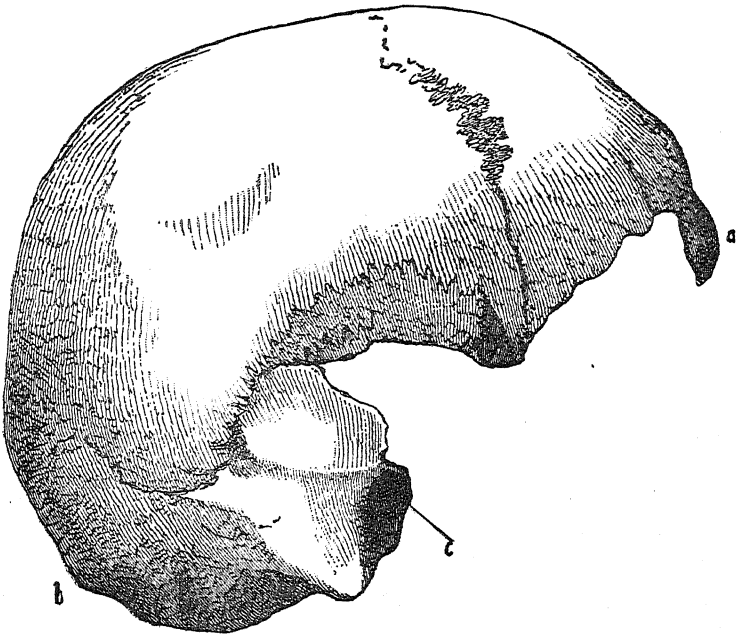


Fig. 23.—The skull from the cave of Engis — viewed from the right side. One half the size of nature. *a* glabella, *b* occipital protuberance (*a* to *b* glabello-occipital line), *c* auditory foramen.

other human remains disinterred at the same time, in his valuable work, "Recherches sur les Ossemens fossiles découverts dans les Cavernes de la Province de Liège," published in 1833 (p. 59, *et seq.*), from which the following paragraphs are extracted, the precise expressions of the author being, as far as possible, preserved.

"In the first place, I must remark that these human remains, which are in my possession, are characterised, like the thousands of bones which

I have lately been disinterring, by the extent of the decomposition which they have undergone, which is precisely the same as that of the extinct species: all, with a few exceptions, are broken; some few are rounded, as is frequently found to be the case in fossil remains of other species. The fractures are vertical or oblique; none of them are eroded; their colour does not differ from that of other fossil bones, and varies from whitish yellow to blackish. All are lighter than recent bones, with the exception of those which have a calcareous incrustation, and the cavities of which are filled with such matter.

"The cranium which I have caused to be figured, Plate I., Figs. 1, 2, is that of an old person. The sutures are beginning to be effaced: all the facial bones are wanting, and of the temporal bones only a fragment of that of the right side is preserved.

"The face and the base of the cranium had been detached before the skull was deposited in the cave, for we were unable to find those parts, though the whole cavern was regularly searched. The cranium was met with at a depth of a metre and a half [five feet nearly] hidden under an osseous breccia, composed of the remains of small animals, and containing one rhinoceros' tusk, with several teeth of horses and of ruminants. This breccia, which has been spoken of above (p. 31), was a metre [3¼ feet about] wide, and rose to the height of a metre and a half above the floor of the cavern, to the walls of which it adhered strongly.

"The earth which contained this human skull exhibited no trace of disturbance: teeth of rhinoceros, horse, hyæna, and bear, surrounded it on all sides.

"The famous Blumenbach * has directed attention to the differences presented by the form and the dimensions of human crania of different races. This important work would have assisted us greatly, if the face, a part essential for the determination of race, with more or less accuracy, had not been wanting in our fossil cranium.

"We are convinced that even if the skull had been complete, it would not have been possible to pronounce, with certainty, upon a single specimen; for individual variations are so numerous in the crania of one and the same race, that one cannot, without laying one's self open to large chances of error, draw any inference from a single fragment of a cranium to the general form of the head to which it belonged.

"Nevertheless, in order to neglect no point respecting the form of this fossil skull, we may observe that, from the first, the elongated and narrow form of the forehead attracted our attention.

"In fact, the slight elevation of the frontal, its narrowness, and the form of the orbit, approximate it more nearly to the cranium of an Ethiopian than to that of an European: the elongated form and the produced occiput are also characters which we believe to be observable in our fossil cranium; but to remove all doubt upon that subject I have caused the contours of the cranium of an European and of an Ethiopian to be drawn and the foreheads represented. Plate II., Figs. 1 and 2,

* *Decas Collectionis suæ craniorum diversarum gentium illustrata.*—Gottingæ, 1790-1820.

and, in the same plate, Figs. 3 and 4, will render the differences easily distinguishable; and a single glance at the figures will be more instructive than a long and wearisome description.

"At whatever conclusion we may arrive as to the origin of the man from whence this fossil skull proceeded, we may express an opinion without exposing ourselves to a fruitless controversy. Each may adopt the hypothesis which seems to him most probable: for my own part, I hold it to be demonstrated that this cranium has belonged to a person of limited intellectual faculties, and we conclude thence that it belonged to a man of a low degree of civilization: a deduction which is borne out by contrasting the capacity of the frontal with that of the occipital region.

"Another cranium of a young individual was discovered in the floor of the cavern beside the tooth of an elephant; the skull was entire when found, but the moment it was lifted it fell into pieces, which I have not, as yet, been able to put together again. But I have represented the bones of the upper jaw, Plate I., Fig. 5. The state of the alveoli and the teeth, shows that the molars had not yet pierced the gum. Detached milk molars and some fragments of a human skull, proceed from this same place. The figure 3 represents a human superior incisor tooth, the size of which is truly remarkable.*

"Figure 4 is a fragment of a superior maxillary bone, the molar teeth of which are worn down to the roots.

"I possess two vertebræ, a first and last dorsal.

"A clavicle of the left side (see Plate III., Fig. 1); although it belonged to a young individual, this bone shows that he must have been of great stature.†

"Two fragments of the radius, badly preserved, do not indicate that the height of the man, to whom they belonged, exceeded five feet and a half.

"As to the remains of the upper extremities, those which are in my possession consist merely of a fragment of an ulna and of a radius (Plate III., Figs. 5 and 6).

"Figure 2, Plate IV., represents a metacarpal bone, contained in the breccia, of which we have spoken; it was found in the lower part above the cranium; add to this some metacarpal bones, found at very different distances, half-a-dozen metatarsals, three phalanges of the hand, and one of the foot.

"This is a brief enumeration of the remains of human bones collected in the cavern of Engis, which has preserved for us the remains of three individuals, surrounded by those of the Elephant, of the Rhinoceros, and of Carnivora of species unknown in the present creation."

* In a subsequent passage, Schmerling remarks upon the occurrence of an incisor tooth "of enormous size" from the caverns of Engihoul. The tooth figured is somewhat long, but its dimensions do not appear to me to be otherwise remarkable.

† The figure of this clavicle measures 5 inches from end to end in a straight line — so that the bone is rather a small than a large one.

From the cave of Engihoul, opposite that of Engis, on the right bank of the Meuse, Schmerling obtained the remains of three other individuals of Man, among which were only two fragments of parietal bones, but many bones of the extremities. In one case, a broken fragment of an ulna was soldered to a like fragment of a radius by stalagmite, a condition frequently observed among the bones of the Cave Bear (*Ursus spelæus*), found in the Belgian caverns.

It was in the cavern of Engis that Professor Schmerling found, incrusted with stalagmite and joined to a stone, the pointed bone implement, which he has figured in Fig. 7 of his Plate XXXVI., and worked flints were found by him in all those Belgian caves, which contained an abundance of fossil bones.

A short letter from M. Geoffroy St. Hilaire, published in the "Comptes Rendus" of the Academy of Sciences of Paris, for July 2nd, 1838, speaks of a visit (and apparently a very hasty one) paid to the collection of Professor "Schermidt" (which is presumably a misprint for Schmerling) at Liège. The writer briefly criticises the drawings which illustrate Schmerling's work, and affirms that the "human cranium is a little longer than it is represented" in Schmerling's figure. The only other remark worth quoting is this:—

> "The aspect of the human bones differs little from that of the cave bones, with which we are familiar, and of which there is a considerable collection in the same place. With respect to their special forms, compared with those of the varieties of recent human crania, few *certain* conclusions can be put forward; for much greater differences exist between the different specimens of well-characterized varieties, than between the fossil cranium of Liège and that of one of those varieties selected as a term of comparison."

Geoffroy St. Hilaire's remarks are, it will be observed, little but an echo of the philosophic doubts of the describer and discoverer of the remains. As to the critique upon Schmerling's figures, I find that the side view given by the latter is really about $\frac{1}{10}$ths of an inch shorter than the original, and that the front view is diminished to about the same extent. Otherwise the representation is not, in any way, inaccurate, but corresponds very well with the cast which is in my possession.

A piece of the occipital bone, which Schmerling seems to have missed, has since been fitted on to the rest of the cranium by an accomplished anatomist, Dr. Spring of Liège, under whose direction an excellent plaster cast was made for Sir Charles Lyell. It is upon and from a duplicate of that cast that my own observa-

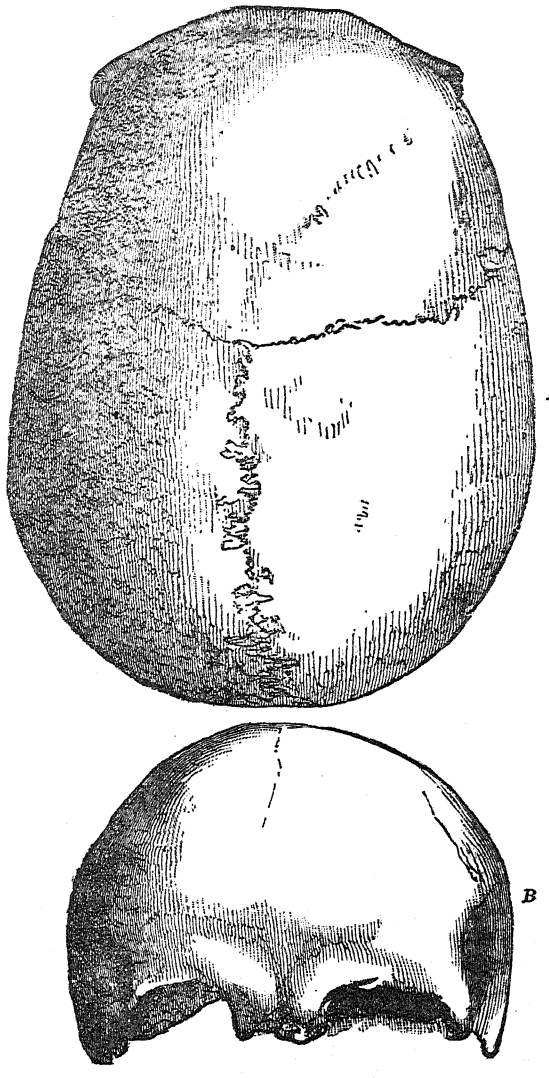


Fig. 24.—The Engis skull viewed from above (*A*) and in front (*B*).

tions and the accompanying figures, the outlines of which are copied from very accurate Camera lucida drawings, by my friend Mr. Busk, reduced to one-half of the natural size, are made.

As Professor Schmerling observes, the base of the skull is destroyed, and the facial bones are entirely absent; but the roof of the cranium, consisting of the frontal, parietal, and the greater part of the occipital bones, as far as the middle of the occipital foramen, is entire, or nearly so. The left temporal bone is wanting. Of the right temporal, the parts in the immediate neighbourhood of the auditory foramen, the mastoid process, and a considerable portion of the squamous element of the temporal are well preserved (Fig. 23).

The lines of fracture which remain between the coadjusted pieces of the skull, and are faithfully displayed in Schmerling's figure, are readily traceable in the cast. The sutures are also discernible, but the complex disposition of their serrations, shown in the figure, is not obvious in the cast. Though the ridges which give attachment to muscles are not excessively prominent, they are well marked, and taken together with the apparently well developed frontal sinuses, and the condition of the sutures, leave no doubt on my mind that the skull is that of an adult, if not middle-aged man.

The extreme length of the skull is 7.7 inches. Its extreme breadth, which corresponds very nearly with the interval between the parietal protuberances, is not more than 5.4 inches. The proportion of the length to the breadth is therefore very nearly as 100 to 70. If a line be drawn from the point at which the brow curves in towards the root of the nose, and which is called the "glabella" (*a*), (Fig. 23), to the occipital protuberance (*b*), and the distance to the highest point of the arch of the skull be measured perpendicularly from this line, it will be found to be 4.75 inches. Viewed from above, Fig. 24, *A*, the forehead presents an evenly rounded curve, and passes into the contour of the sides and back of the skull, which describes a tolerably regular elliptical curve.

The front view (Fig 24, *B*) shows that the roof of the skull was very regularly and elegantly arched in the transverse direction, and that the transverse diameter was a little less below the parietal protuberances, than above them. The forehead cannot be called narrow in relation to the rest of the skull, nor can it be called a retreating forehead; on the contrary, the antero-posterior contour of the skull is well arched, so that the distance along that contour, from the nasal depression to the occipital protuberance, measures about 13.75 inches. The transverse arc of the skull, measured from one auditory foramen to the other, across the middle of the sagittal suture, is about 13 inches. The sagittal suture itself is 5.5 inches long.

The supraciliary prominences or brow-ridges (on each side of *a*, Fig. 23) are well, but not excessively, developed, and are separated by a median depression. Their principal elevation is disposed so obliquely that I judge them to be due to large frontal sinuses.

If a line joining the glabella and the occipital protuberance (*a*, *b*, Fig. 23) be made horizontal, no part of the occipital region projects more than $\frac{1}{10}$th of an inch behind the posterior extremity of that line, and the upper edge of the auditory foramen (*c*) is almost in contact with a line drawn parallel with this upon the outer surface of the skull.

A transverse line drawn from one auditory foramen to the other traverses, as usual, the fore part of the occipital foramen. The capacity of the interior of this fragmentary skull has not been ascertained.

The history of the Human remains from the cavern in the Neanderthal may best be given in the words of their original describer, Dr. Schaaffhausen,* as translated by Mr. Busk.

"In the early part of the year 1857, a human skeleton was discovered in a limestone cave in the Neanderthal, near Hochdal, between Düsseldorf and Elberfeld. Of this, however, I was unable to procure more than a plaster cast of the cranium, taken at Elberfeld, from which I drew up an account of its remarkable conformation, which was, in the first instance, read on the 4th of February, 1857, at the meeting of the Lower Rhine Medical and Natural History Society, at Bonn.† Subsequently Dr. Fuhlrott, to whom science is indebted for the preservation of these bones, which were not at first regarded as human, and into whose possession they afterwards came, brought the cranium from Elberfeld to Bonn, and entrusted it to me for more accurate anatomical examination. At the General Meeting of the Natural History Society of Prussian Rhineland and Westphalia, at Bonn, on the 2nd of June 1857,‡ Dr. Fuhlrott himself gave a full account of the locality, and of the circumstances under which the discovery was made. He was of opinion that the bones might be regarded as fossil; and in coming to this conclusion, he laid especial stress upon the existence of dendritic deposits, with which their surface was covered, and which were first noticed upon them by Professor Mayer. To this communication I appended a brief report on the results of my anatomical examination of the bones. The conclusions

* *On the Crania of the most Ancient Races of Man.*—By Professor D. Schaaffhausen, of Bonn. (From Müller's *Archiv.*, 1858, p. 453.) With Remarks, and Original Figures, taken from a Cast of the Neanderthal Cranium. By George Busk, F.R.S., &c. *Natural History Review*, April, 1861.

† *Verhandl. d. Naturhist. Vereins der preuss. Rheinlande und Westphalens.*, xiv.—Bonn, 1857.

‡ *Ib.* Correspondenzblatt. No. 2.

at which I arrived were: 1st. That the extraordinary form of the skull was due to a natural conformation hitherto not known to exist, even in the most barbarous races. 2nd. That these remarkable human remains belonged to a period antecedent to the time of the Celts and Germans, and were in all probability derived from one of the wild races of North-western Europe, spoken of by Latin writers; and which were encountered as autochthones by the German immigrants. And 3rdly. That it was beyond doubt that these human relics were traceable to a period at which the latest animals of the diluvium still existed; but that no proof of this assumption, nor consequently of their so-termed *fossil* condition, was afforded by the circumstances under which the bones were discovered.

"As Dr. Fuhlrott has not yet published his description of these circumstances, I borrow the following account of them from one of his letters. 'A small cave or grotto, high enough to admit a man, and about 15 feet deep from the entrance, which is 7 or 8 feet wide, exists in the southern wall of the gorge of the Neanderthal, as it is termed, at a distance of about 100 feet from the Düssel, and about 60 feet above the bottom of the valley. In its earlier and uninjured condition, this cavern opened upon a narrow plateau lying in front of it, and from which the rocky wall descended almost perpendicularly into the river. It could be reached, though with difficulty, from above. The uneven floor was covered to a thickness of 4 or 5 feet with a deposit of mud, sparingly intermixed with rounded fragments of chert. In the removing of this deposit, the bones were discovered. The skull was first noticed, placed nearest to the entrance of the cavern; and further in, the other bones, lying in the same horizontal plane. Of this I was assured, in the most positive terms, by two labourers who were employed to clear out the grotto, and who were questioned by me on the spot. At first no idea was entertained of the bones being human; and it was not till several weeks after their discovery that they were recognised as such by me, and placed in security.

"'But, as the importance of the discovery was not at the time perceived, the labourers were very careless in the collecting, and secured chiefly only the larger bones; and to this circumstance it may be attributed that fragments merely of the probably perfect skeleton came into my possession.'

"My anatomical examination of these bones afforded the following results:—

"The cranium is of unusual size, and of a long-elliptical form. A most remarkable peculiarity is at once obvious in the extraordinary development of the frontal sinuses, owing to which the superciliary ridges, which coalesce completely in the middle, are rendered so prominent, that the frontal bone exhibits a considerable hollow or depression above, or rather behind them, whilst a deep depression is also formed in the situation of the root of the nose. The forehead is narrow and low, though the middle and hinder portions of the cranial arch are well developed. Unfortunately, the fragment of the skull that has been preserved consists only of the portion situated above the roof of the orbits and the

superior occipital ridges, which are greatly developed, and almost conjoined so as to form a horizontal eminence. It includes almost the whole of the frontal bone, both parietals, a small part of the squamous and the upper-third of the occipital. The recently fractured surfaces show that the skull was broken at the time of its disinterment. The cavity holds 16,876 grains of water, whence its cubical contents may be estimated at 57.64 inches, or 1033.24 cubic centimetres. In making this estimation, the water is supposed to stand on a level with the orbital plate of the frontal, with the deepest notch in the squamous margin of the parietal, and with the superior semicircular ridges of the occipital. Estimated in dried millet-seed, the contents equalled 31 ounces, Prussian Apothecaries' weight. The semicircular line indicating the upper boundary of the attachment of the temporal muscle, though not very strongly marked, ascends nevertheless to more than half the height of the parietal bone. On the right superciliary ridge is observable an oblique furrow or depression, indicative of an injury received during life.* The coronal and sagittal sutures are on the exterior nearly closed, and on the inside so completely ossified as to have left no traces whatever, whilst the lambdoidal remains quite open. The depressions for the Pacchionian glands are deep and numerous; and there is an unusually deep vascular groove immediately behind the coronal suture, which, as it terminates in a foramen, no doubt transmitted a *vena emissaria*. The course of the frontal suture is indicated externally by a slight ridge; and where it joins the coronal, this ridge rises into a small protuberance. The course of the sagittal suture is grooved, and above the angle of the occipital bone the parietals are depressed.

	mm.†	inches.
The length of the skull from the nasal process of the frontal over the vertex to the superior semicircular lines of the occipital measures.	303 (300)	= 12.0".
Circumference over the orbital ridges and the superior semicircular lines of the occipital.	590 (590)	= 23.37" or 23".
Width of the frontal from the middle of the temporal line on one side to the same point on the opposite.....	104 (114)	= 4.1"—4.5".
Length of the frontal from the nasal process to the coronal suture.....	133 (125)	= 5.25"—5".
Extreme width of the frontal sinuses.....	25 (23)	= 1.0"—0.9".
Vertical height above a line joining the deepest notches in the squamous border of the parietals	70	= 2.75".
Width of hinder part of skull from one parietal protuberance to the other.....	138 (150)	= 5.4"—5.9".
Distance from the upper angle of the occipital to the superior semicircular lines.....	51 (60)	= 1.9"—2.4".

* This, Mr. Busk has pointed out, is probably the notch for the frontal nerve.

† The numbers in parentheses are those which I should assign to the different measures, as taken from the plaster cast.—G. B.

	mm.	inches.
Thickness of the bone at the parietal protuberance	8.	
———at the angle of the occipital	9.	
———at the superior semicircular line of the occipital	10	= 0.3″.

"Besides the cranium, the following bones have been secured:—

"1. Both thigh-bones, perfect. These, like the skull, and all the other bones, are characterized by their unusual thickness, and the great development of all the elevations and depressions for the attachment of muscles. In the Anatomical Museum at Bonn, under the designation of 'Giant's bones,' are some recent thigh-bones, with which in thickness the foregoing pretty nearly correspond, although they are shorter.

	Giant's bones. mm. inches.	Fossil bones. mm. inches.
Length	542 = 21.4″	438 = 17.4″
Diameter of head of femur	54 = 2.14″	53 = 2.0″.
Diameter of lower articular end, from one condyle to the other	89 = 3.5″	87 = 3.4″.
Diameter of femur in the middle	33 = 1.2″	30 = 1.1″.

"2. A perfect right humerus, whose size shows that it belongs to the thigh-bones.

	mm.	inches.
Length	312	= 12.3′.
Thickness in the middle	26	= 1.0″.
Diameter of head	49	= 1.9″.

"Also a perfect right radius of corresponding dimensions and the upper-third of a right ulna corresponding to the humerus and radius.

"3. A left humerus, of which the upper-third is wanting, and which is so much slenderer than the right as apparently to belong to a distinct individual; a left *ulna*, which, though complete, is pathologically deformed, the coronoid process being so much enlarged by bony growth, that flexure of the elbow beyond a right angle must have been impossible; the anterior fossa of the humerus for the reception of the coronoid process being also filled up with a similar bony growth. At the same time, the olecranon is curved strongly downwards. As the bone presents no sign of rachitic degeneration, it may be supposed that an injury sustained during life was the cause of the anchylosis. When the left ulna is compared with the right radius, it might at first sight be concluded that the bones respectively belonged to different individuals, the ulna being more than half an inch too short for articulation with a corresponding radius. But it is clear that this shortening, as well as the attenuation of the left humerus, are both consequent upon the pathological condition above described.

"4. A left *ilium*, almost perfect, and belonging to the femur; a fragment of the right *scapula;* the anterior extremity of a rib of the right side; and the same part of a rib of the left side; the hinder part of a rib of the right side; and, lastly, two hinder portions and one middle portion of ribs which, from their unusually rounded shape, and abrupt curvature, more resemble the ribs of a carnivorous animal than those of

a man. Dr. H. v. Meyer, however, to whose judgment I defer, will not venture to declare them to be ribs of any animal; and it only remains to suppose that this abnormal condition has arisen from an unusually powerful development of the thoracic muscles.

"The bones adhere strongly to the tongue, although, as proved by the use of hydrochloric acid, the greater part of the cartilage is still retained in them, which appears, however, to have undergone that transformation into gelatine which has been observed by v. Bibra in fossil bones. The surface of all the bones is in many spots covered with minute black specks, which, more especially under a lens, are seen to be formed of very delicate *dendrites*. These deposits, which were first observed on the bones by Dr. Mayer, are most distinct on the inner surface of the cranial bones. They consist of a ferruginous compound, and, from their black colour, may be supposed to contain manganese. Similar dendritic formations also occur, not unfrequently, on laminated rocks, and are usually found in minute fissures and cracks. At the meeting of the Lower Rhine Society at Bonn, on the 1st April, 1857, Prof. Mayer stated that he had noticed in the museum of Poppelsdorf similar dendritic crystallizations on several fossil bones of animals, and particularly on those of *Ursus spelæus*, but still more abundantly and beautifully displayed on the fossil bones and teeth of *Equus adamiticus*, *Elephas primigenius*, &c., from the caves of Bolve and Sundwig. Faint indications of similar *dendrites* were visible in a Roman skull from Siegburg; whilst other ancient skulls, which had lain for centuries in the earth, presented no trace of them.* I am indebted to H. v. Meyer for the following remarks on this subject:—

"'The incipient formation of dendritic deposits, which were formerly regarded as a sign of a truly fossil condition, is interesting. It has even been supposed that in diluvial deposits the presence of *dendrites* might be regarded as affording a certain mark of distinction between bones mixed with the diluvium at a somewhat later period and the true diluvial relics, to which alone it was supposed that these deposits were confined. But I have long been convinced that neither can the absence of *dendrites* be regarded as indicative of recent age, nor their presence as sufficient to establish the great antiquity of the objects upon which they occur. I have myself noticed upon paper, which could scarcely be more than a year old, dendritic deposits, which could not be distinguished from those on fossil bones. Thus I possess a dog's skull from the Roman colony of the neighbouring Heddersheim, *Castrum Hadrianum*, which is in no way distinguishable from the fossil bones from the Frankish caves; it presents the same colour, and adheres to the tongue just as they do; so that this character also, which, at a former meeting of German naturalists at Bonn, gave rise to amusing scenes between Buckland and Schmerling, is no longer of any value. In disputed cases, therefore, the condition of the bone can scarcely afford the means for determining with certainty whether it be fossil, that is to say, whether it belong to geological antiquity or to the historical period.'

* *Verh. des Naturhist.* Vereins in Bonn, xiv. 1857.

"As we cannot now look upon the primitive world as representing a wholly different condition of things, from which no transition exists to the organic life of the present time, the designation of *fossil*, as applied to *a bone*, has no longer the sense it conveyed in the time of Cuvier. Sufficient grounds exist for the assumption that man coexisted with the animals found in the *diluvium;* and many a barbarous race may, before all historical time, have disappeared, together with the animals of the ancient world, whilst the races whose organization is improved have continued the genus. The bones which form the subject of this paper present characters which, although not decisive as regards a geological epoch, are, nevertheless, such as indicate a very high antiquity. It may also be remarked that, common as is the occurrence of diluvial animal bones in the muddy deposits of caverns, such remains have not hitherto been met with in the caves of the Neanderthal; and that the bones, which were covered by a deposit of mud not more than four or five feet thick, and without any protective covering of stalagmite, have retained the greatest part of their organic substance.

"These circumstances might be adduced against the probability of a geological antiquity. Nor should we be justified in regarding the cranial conformation as perhaps representing the most savage primitive type of the human race, since crania exist among living savages, which, though not exhibiting such a remarkable conformation of the forehead, which gives the skull somewhat the aspect of that of the large apes, still in other respects, as for instance in the greater depth of the temporal fossæ, the crest-like, prominent temporal ridges, and a generally less capacious cranial cavity, exhibit an equally low stage of development. There is no reason for supposing that the deep frontal hollow is due to any artificial flattening, such as is practised in various modes by barbarous nations in the Old and New World. The skull is quite symmetrical, and shows no indication of counter-pressure at the occiput, whilst, according to Morton, in the Flat-heads of the Columbia, the frontal and parietal bones are always unsymmetrical. Its conformation exhibits the sparing development of the anterior part of the head which has been so often observed in very ancient crania, and affords one of the most striking proofs of the influence of culture and civilization on the form of the human skull."

In a subsequent passage, Dr. Schaaffhausen remarks:

"There is no reason whatever for regarding the unusual development of the frontal sinuses in the remarkable skull from the Neanderthal as an individual or pathological deformity; it is unquestionably a typical race-character, and is physiologically connected with the uncommon thickness of the other bones of the skeleton, which exceeds by about one-half the usual proportions. This expansion of the frontal sinuses, which are appendages of the air-passages, also indicates an unusual force and power of endurance in the movements of the body, as may be concluded from the size of all the ridges and processes for the attachment of the muscles or bones. That this conclusion may be drawn from the existence

of large frontal sinuses, and a prominence of the lower frontal region, is confirmed in many ways by other observations. By the same characters, according to Pallas, the wild horse is distinguished from the domesticated, and, according to Cuvier, the fossil cave-bear from every recent species of bear, whilst, according to Roulin, the pig, which has become wild in America, and regained a resemblance to the wild boar, is thus distinguished from the same animal in the domesticated state, as is the chamois from the goat; and, lastly, the bull-dog, which is characterised by its large bones and strongly-developed muscles from every other kind of dog. The estimation of the facial angle, the determination of which, according to Professor Owen, is also difficult in the great apes, owing to the very prominent supra-orbital ridges, in the present case is rendered still more difficult from the absence both of the auditory opening and of the nasal spine. But if the proper horizontal position of the skull be taken from the remaining portions of the orbital plates, and the ascending line made to touch the surface of the frontal bone behind the prominent supra-orbital ridges, the facial angle is not found to exceed 56°.* Unfortunately, no portions of the facial bones, whose conformation is so decisive as regards the form and expression of the head, have been preserved. The cranial capacity, compared with the uncommon strength of the corporeal frame, would seem to indicate a small cerebral development. The skull, as it is, holds about 31 ounces of millet-seed; and as, from the proportionate size of the wanting bones, the whole cranial cavity should have about 6 ounces more added, the contents, were it perfect, may be taken at 37 ounces. Tiedemann assigns, as the cranial contents in the Negro, 40, 38, and 35 ounces. The cranium holds rather more than 36 ounces of water which corresponds to a capacity of 1033.24 cubic centimetres. Huschke estimates the cranial contents of a Negress at 1127 cubic centimetres; of an old Negro at 1146 cubic centimetres. The capacity of the Malay skulls, estimated by water, equalled 36, 33 ounces, whilst in the diminutive Hindoos it falls to as little as 27 ounces."

After comparing the Neanderthal cranium with many others, ancient and modern, Professor Schaaffhausen concludes thus:—

"But the human bones and cranium from the Neanderthal exceed all the rest in those peculiarities of conformation which lead to the conclusion of their belonging to a barbarous and savage race. Whether the cavern in which they were found, unaccompanied with any trace of human art, were the place of their interment, or whether, like the bones of extinct animals elsewhere, they had been washed into it, they may still be regarded as the most ancient memorial of the early inhabitants of Europe."

Mr. Busk, the translator of Dr. Schaaffhausen's paper, has enabled us to form a very vivid conception of the degraded char-

* Estimating the facial angle in the way suggested, on the cast I should place it at 64° to 67°.—G. B.

acter of the Neanderthal skull, by placing side by side with its outline, that of the skull of a Chimpanzee, drawn to the same absolute size.

Some time after the publication of the translation of Professor Schaaffhausen's Memoir, I was led to study the cast of the Neanderthal cranium with more attention than I had previously bestowed upon it, in consequence of wishing to supply Sir Charles Lyell with a diagram, exhibiting the special peculiarities of this skull, as compared with other human skulls. In order to do this it was necessary to identify, with precision, those points in the skulls compared which corresponded anatomically. Of these points, the glabella was obvious enough; but when I had distinguished another, defined by the occipital protuberance and superior semicircular line, and had placed the outline of the Neanderthal skull against that of the Engis skull, in such a position that the glabella and occipital protuberance of both were intersected by the same straight line, the difference was so vast and the flattening of the Neanderthal skull so prodigious (compare Figs. 23 and 25 A), that I at first imagined I must have fallen into some error. And I was the more inclined to suspect this, as, in ordinary human skulls, the occipital protuberance and superior semicircular curved line on the exterior of the occiput correspond pretty closely with the "lateral sinuses" and the line of attachment of the tentorium internally. But on the tentorium rests, as I have said in the preceding Essay, the posterior lobe of the brain; and hence, the occipital protuberance, and the curved line in question, indicate, approximately, the lower limits of that lobe. Was it possible for a human being to have the brain thus flattened and depressed; or, on the other hand, had the muscular ridges shifted their position? In order to solve these doubts, and to decide the question whether the great supraciliary projections did, or did not, arise from the development of the frontal sinuses, I requested Sir Charles Lyell to be so good as to obtain for me from Dr. Fuhlrott, the possessor of the skull, answers to certain queries, and if possible a cast, or at any rate drawings, or photographs, of the interior of the skull.

Dr. Fuhlrott replied, with a courtesy and readiness for which I am infinitely indebted to him, to my inquiries, and furthermore sent three excellent photographs. One of these gives a side view of the skull, and from it Fig. 25 A has been shaded. The second (Fig. 26 A) exhibits the wide openings of the frontal sinuses upon the inferior surface of the frontal part of the skull, into which, Dr. Fuhlrott writes, "a probe may be introduced to the depth of an inch," and demonstrates the great extension of the

thickened supraciliary ridges beyond the cerebral cavity. The third, lastly (Fig. 26 B), exhibits the edge and the interior of the posterior, or occipital, part of the skull, and shows very clearly the two depressions for the lateral sinuses, sweeping inwards towards the middle line of the roof of the skull, to form the longitudinal sinus. It was clear, therefore, that I had not erred in my interpretation, and that the posterior lobe of the brain

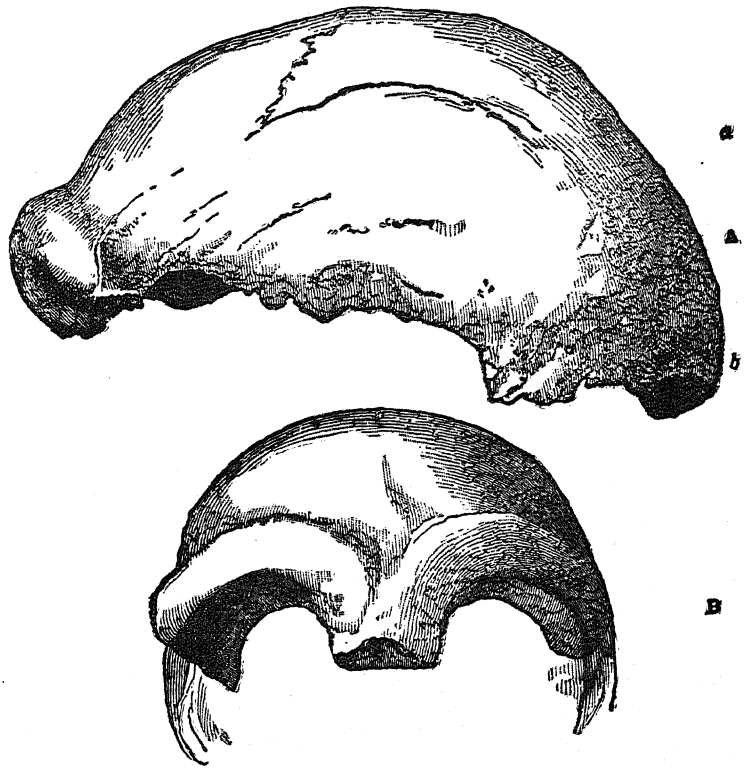
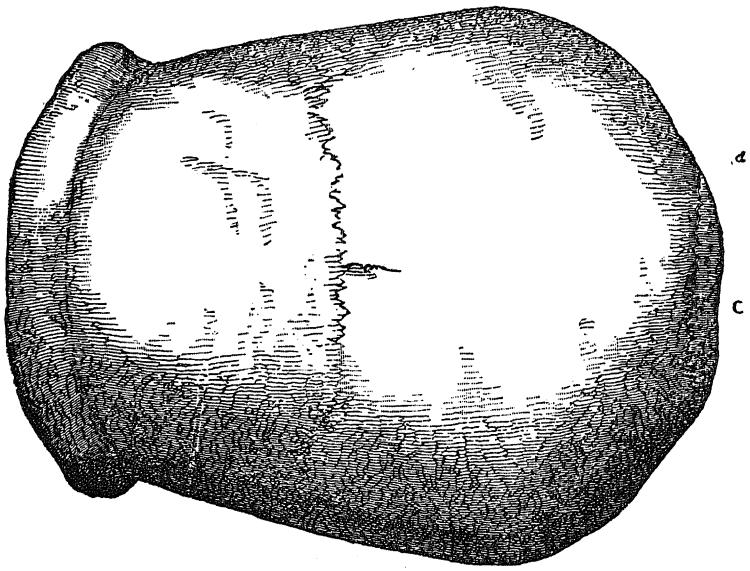


Fig. 25.—The skull from the Neanderthal cavern. A, side, B, front, and C, top view. One half the natural size. The outlines from camera

of the Neanderthal man must have been as much flattened as I suspected it to be.

In truth, the Neanderthal cranium has most extraordinary characters. It has an extreme length of 8 inches, while its breadth is only 5.75 inches, or, in other words, its length is to its breadth

as 100 : 72. It is exceedingly depressed, measuring only about 3.4 inches from the glabello-occipital line to the vertex. The longitudinal arc, measured in the same way as in the Engis skull, is 12 inches; the transverse arc cannot be exactly ascertained, in consequence of the absence of the temporal bones, but was probably about the same, and certainly exceeded 10¼ inches. The horizontal circumference is 23 inches. But this great circumference arises largely from the vast development of the supraciliary ridges, though the perimeter of the brain case itself is



lucida drawings, one half the natural size, by Mr. Busk; he details from the cast and from Dr. Fuhlrott's photographs. *a* glabella; *b* occipital protuberance; *d* lambdoidal suture.

not small. The large supraciliary ridges give the forehead a far more retreating appearance than its internal contour would bear out.

To an anatomical eye, the posterior part of the skull is even more striking than the anterior. The occipital protuberance occupies the extreme posterior end of the skull, when the glabello-occipital line is made horizontal, and so far from any part of the occipital region extending beyond it, this region of the skull slopes obliquely upward and forward, so that the lambdoidal suture is situated well upon the upper surface of the cranium. At

the same time, notwithstanding the great length of the skull, the sagittal suture is remarkably short (4½ inches), and the squamosal suture is very straight.

In reply to my questions Dr. Fuhlrott writes that the occipital bone "is in a state of perfect preservation as far as the upper semicircular line, which is a very strong ridge, linear at its extremities, but enlarging towards the middle, where it forms two ridges (bourrelets), united by a linear continuation, which is slightly depressed in the middle."

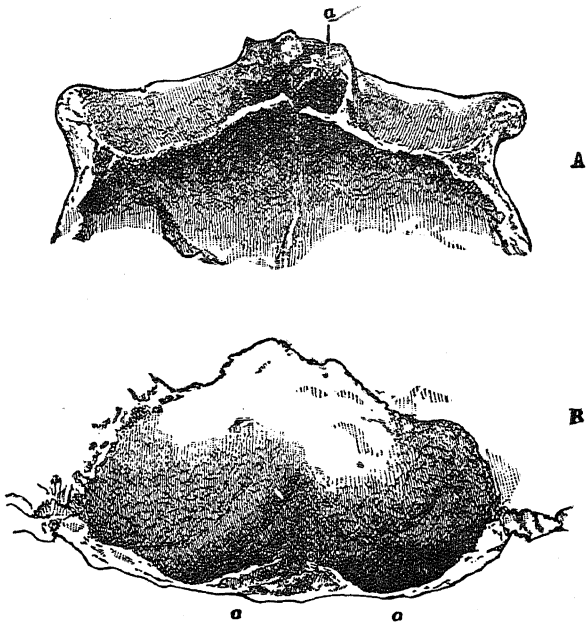


Fig. 26.— Drawings from Dr. Fuhlrott's photographs of parts of the interior of the Neanderthal cranium. A view of the under and inner surface of the frontal region, showing the inferior apertures of the frontal sinuses (*a*). B corresponding view of the occipital region of the skull, showing the impressions of the lateral sinuses (*aa*).

"Below the left ridge the bone exhibits an obliquely inclined surface, six lines (French) long, and twelve lines wide."

This last must be the surface, the contour of which is shown in Fig. 25 A, below *b*. It is particularly interesting, as it suggests that, notwithstanding the flattened condition of the occiput, the posterior cerebral lobes must have projected considerably beyond the cerebellum, and as it constitutes one among several points of

similarity between the Neanderthal cranium and certain Australian skulls.

Such are the two best known forms of human cranium, which have been found in what may be fairly termed a fossil state. Can either be shown to fill up or diminish, to any appreciable extent, the structural interval which exists between Man and the man-like apes? Or, on the other hand, does neither depart more widely from the average structure of the human cranium, than normally formed skulls of men are known to do at the present day?

It is impossible to form any opinion on these questions, without some preliminary acquaintance with the range of variation exhibited by human structure in general, a subject which has been but imperfectly studied, while even of what is known, my limits will necessarily allow me to give only a very imperfect sketch.

The student of anatomy is perfectly well aware that there is not a single organ of the human body the structure of which does not vary, to a greater or less extent, in different individuals. The skeleton varies in the proportions, and even to a certain extent in the connections, of its constituent bones. The muscles which move the bones vary largely in their attachments. The varieties in the mode of distribution of the arteries are carefully classified, on account of the practical importance of a knowledge of their shiftings to the surgeon. The characters of the brain vary immensely, nothing being less constant than the form and size of the cerebral hemispheres, and the richness of the convolutions upon their surface, while the most changeable structures of all in the human brain are exactly those on which the unwise attempt has been made to base the distinctive characters of humanity, viz. the posterior cornu of the lateral ventricle, the hippocampus minor, and the degree of projection of the posterior lobe beyond the cerebellum. Finally, as all the world knows, the hair and skin of human beings may present the most extraordinary diversities in colour and in texture.

So far as our present knowledge goes, the majority of the structural varieties to which allusion is here made, are individual. The ape-like arrangement of certain muscles which is occasionally met with* in the white races of mankind, is not known to be more common among Negroes or Australians: nor because the brain of the Hottentot Venus was found to be smoother, to have its convolutions more symmetrically disposed, and to be, so far,

* See an excellent Essay by Mr. Church on the Myology of the Orang, in the *Natural History Review* for 1861.

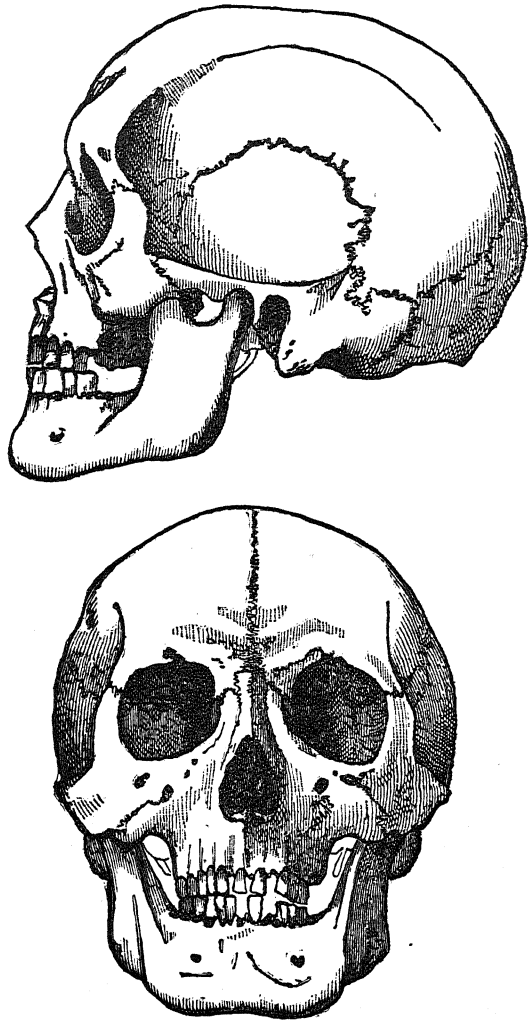


Fig. 27.—Side and front views of the round and orthognathous skull of a Calmuck after Van Baer. One-third the natural size.

more ape-like than that of ordinary Europeans, are we justified in concluding a like condition of the brain to prevail universally among the lower races of mankind, however probable that conclusion may be.

We are, in fact, sadly wanting in information respecting the disposition of the soft and destructible organs of every Race of Mankind but our own; and even of the skeleton, our Museums are lamentably deficient in every part but the cranium. Skulls enough there are, and since the time when Blumenbach and Camper first called attention to the marked and singular differences which they exhibit, skull collecting and skull measuring has been a zealously pursued branch of Natural History, and the results obtained have been arranged and classified by various writers, among whom the late active and able Retzius must always be the first named.

Human skulls have been found to differ from one another, not merely in their absolute size and in the absolute capacity of the brain case, but in the proportions which the diameters of the latter bear to one another; in the relative size of the bones of the face (and more particularly of the jaws and teeth) as compared with those of the skull; in the degree to which the upper jaw (which is of course followed by the lower) is thrown backwards and downwards under the fore part of the brain case, or forwards and upwards in front of and beyond it. They differ further in the relations of the tranverse diameter of the face, taken through the cheek bones, to the transverse diameter of the skull; in the more rounded or more gable-like form of the roof of the skull, and in the degree to which the hinder part of the skull is flattened or projects beyond the ridge, into and below which the muscles of the neck are inserted.

In some skulls the brain case may be said to be "*round*," the extreme length not exceeding the extreme breadth by a greater proportion than 100 to 80, while the difference may be much less.* Men possessing such skulls were termed by Retzius "*brachycephalic*," and the skull of a Calmuck, of which a front and side view (reduced outline copies of which are given in Fig. 27) are depicted by Von Baer in his excellent "Crania selecta," affords a very admirable sample of that kind of skull. Other skulls, such as that of a Negro copied in Fig. 28 from Mr. Busk's "Crania typica," have a very different, greatly elongated form, and may be termed "*oblong*." In this skull the extreme length is to the extreme breadth as 100 to not more than 67, and the transverse diameter of the human skull may fall below even this proportion. People having such skulls were called by Retzius "*dolichocephalic*."

The most cursory glance at the side views of these two skulls

* In no normal human skull does the breadth of the brain case exceed its length.

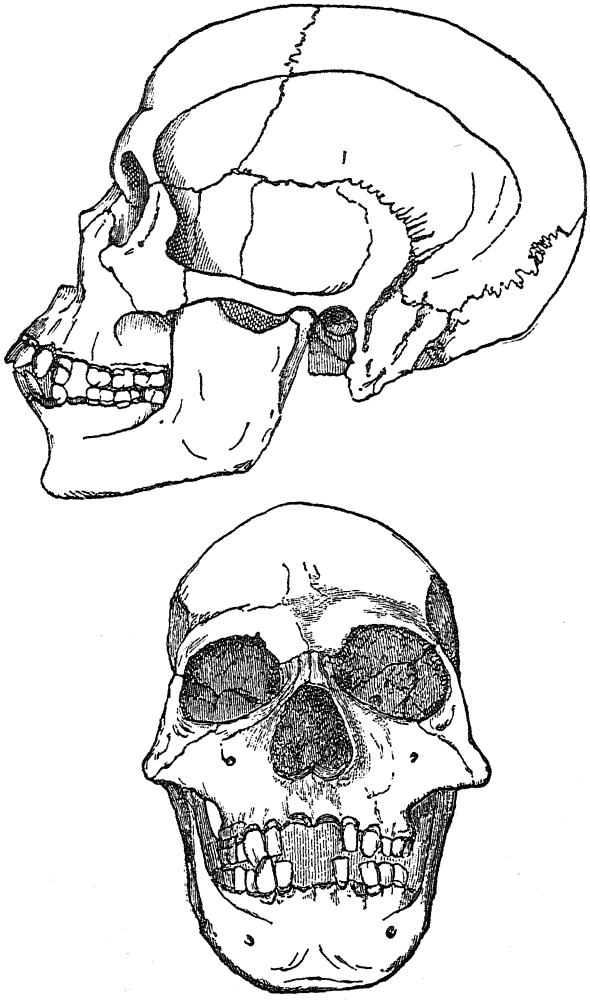


Fig. 28.—Oblong and prognathous skull of a Negro; side and front views. One-third of the natural size.

will suffice to prove that they differ, in another respect, to a very striking extent. The profile of the face of the Calmuck is almost vertical, the facial bones being thrown downwards and under the fore part of the skull. The profile of the face of the Negro, on the other hand, is singularly inclined, the front part of the jaws

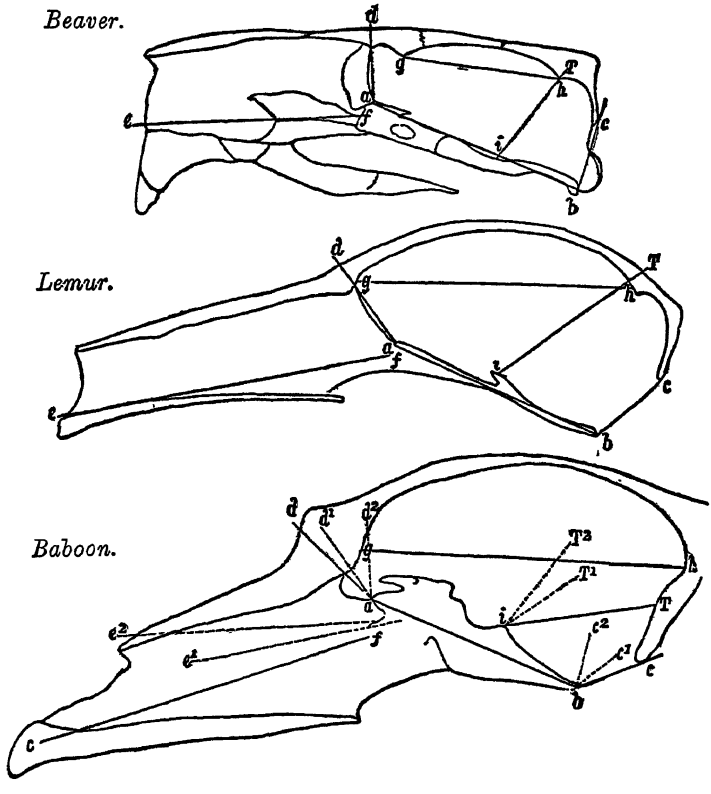


Fig. 29.—Longitudinal and vertical sections of the skulls of a Beaver (*Castor Canadensis*), a Lemur (*L. Catta*), and a Baboon (*Cynocephalus Papio*), *a b*, the basicranial axis; *b c*, the occipital plane; *i T*, the tentorial plane; *a d*, the olfactory plane; *f e*, the basifacial axis; *c b a*, occipital angle; *T i a*, tentorial angle; *d a b*, olfactory angle; *e f b*, craniofacial angle; *g h*, extreme length of the cavity which lodges the cerebral hemispheres or "cerebral length." The length of the basicranial axis as to this length, or, in other words, the proportional length of the line *g h* to that of *a b* taken as 100, in the three skulls, is as follows:—Beaver, 70 to 100; Lemur, 119 to 100; Baboon, 144 to 100. In an adult male Gorilla the cerebral length is as 170 to the basicranial axis taken as 100, in the Negro (Fig. 30) as 236 to 100. In the Constantinople skull (Fig. 30) it is as 266 to 100. The difference between the highest Ape's skull and the lowest Man's is therefore very strikingly brought out by these measurements.

In the diagram of the Baboon's skull the dotted lines d^1 d^2, &c., give the angles of the Lemur's and Beaver's skull, as laid down upon the basicranial axis of the Baboon. The line *a b* has the same length in each diagram.

projecting far forward beyond the level of the fore part of the skull. In the former case the skull is said to be "*orthognathous*" or straight-jawed; in the latter, it is called "*prognathous*," a term which has been rendered, with more force than elegance, by the Saxon equivalent,—"snouty."

Various methods have been devised in order to express with some accuracy the degree of prognathism or orthognathism of any given skull; most of these methods being essentially modifications of that devised by Peter Camper, in order to attain what he called the "facial angle."

But a little consideration will show that any "facial angle" that has been devised, can be competent to express the structural modifications involved in prognathism and orthognathism, only in a rough and general sort of way. For the lines, the intersection of which forms the facial angle, are drawn through points of the skull, the position of each of which is modified by a number of circumstances, so that the angle obtained is a complex resultant of all these circumstances, and is not the expression of any one definite organic relation of the parts of the skull.

I have arrived at the conviction that no comparison of crania is worth very much that is not founded upon the establishment of a relatively fixed base line, to which the measurements, in all cases, must be referred. Nor do I think it is a very difficult matter to decide what that base line should be. The parts of the skull, like those of the rest of the animal framework, are developed in succession: the base of the skull is formed before its sides and roof; it is converted into cartilage earlier and more completely than the sides and roof: and the cartilaginous base ossifies, and becomes soldered into one piece long before the roof. I conceive then that the base of the skull may be demonstrated developmentally to be its relatively fixed part, the roof and sides being relatively movable.

The same truth is exemplified by the study of the modifications which the skull undergoes in ascending from the lower animals up to man.

In such a mammal as a Beaver (Fig. 29), a line (*a b*) drawn through the bones, termed basioccipital, basisphenoid, and presphenoid, is very long in proportion to the extreme length of the cavity which contains the cerebral hemispheres (*g h*). The plane of the occipital foramen (*b c*) forms a slightly acute angle with this "basicranial axis," while the plane of the tentorium (*i T*) is inclined at rather more than 90° to the "basicranial axis"; and so is the plane of the perforated plate (*a d*), by which the filaments of the olfactory nerve leave the skull. Again, a line

drawn through the axis of the face, between the bones called ethmoid and vomer — the "basifacial axis" (*f. e.*) forms an exceedingly obtuse angle, where, when produced, it cuts the "basicranial axis."

If the angle made by the line *b c* with *a b*, be called the "occipital angle," and the angle made by the line *a d* with *a b* be termed the

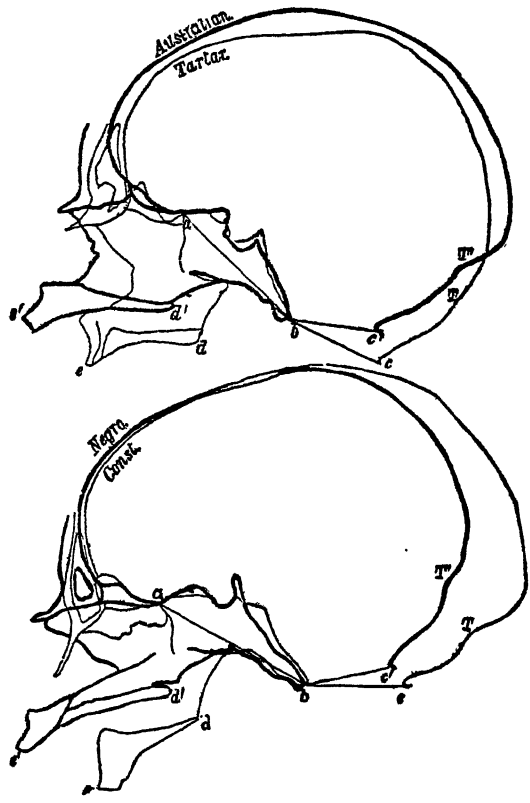


Fig. 30.—Sections of orthognathous (light contour) and [illegible]athous (dark contour) skulls, one-third of the natural size. *a b*, Basicranial axis; *b c*, *b' c'*, plane of the occipital foramen; *d d'*, hinder end of the palatine bone; *e e'* front end of the upper jaw; *T T''*, insertion of the tentorium.

"olfactory angle" and that made by *i T* with *a b* the "tentorial angle" then all these, in the mammal in question, are nearly right angles, varying between 80° and 110°. The angle *e f b*, or that made by the cranial with the facial axis, and which may

be termed the "craniofacial angle," is extremely obtuse, amounting, in the case of the Beaver, to at least 150°.

But if a series of sections of mammalian skulls, intermediate between a Rodent and a Man (Fig. 29), be examined, it will be found that in the higher crania the basicranial axis becomes shorter relatively to the cerebral length; that the "olfactory angle" and "occipital angle" become more obtuse; and that the "craniofacial angle," becomes more acute by the bending down, as it were, of the facial axis upon the cranial axis. At the same time, the roof of the cranium becomes more and more arched, to allow of the increasing height of the cerebral hemispheres, which is eminently characteristic of man, as well as of that backward extension, beyond the cerebellum, which reaches its maximum in the South American Monkeys. So that, at last, in the human skull (Fig. 30), the cerebral length is between twice and thrice as great as the length of the basicranial axis; the olfactory plane is 20° or 30° on the *under* side of that axis; the occipital angle, instead of being less than 90°, is as much as 150° or 160°; the cranio-facial angle may be 90° or less, and the vertical height of the skull may have a large proportion to its length.

It will be obvious, from an inspection of the diagrams, that the basicranial axis is, in the ascending series of Mammalia, a relatively fixed line, on which the bones of the sides and roof of the cranial cavity, and of the face, may be said to revolve downwards and forwards or backwards, according to their position. The arc described by any one bone or plane, however, is not by any means always in proportion to the arc described by another.

Now comes the important question, can we discern, between the lowest and the highest forms of the human cranium anything answering, in however slight a degree, to this revolution of the side and roof bones of the skull upon the basicranial axis observed upon so great a scale in the mammalian series? Numerous observations lead me to believe that we must answer this question in the affirmative.

The diagrams in Fig. 30 are reduced from very carefully made diagrams of sections of four skulls, two round and orthognathous, two long and prognathous, taken longitudinally and vertically, through the middle. The sectional diagrams have then been superimposed, in such a manner, that the basal axes of the skulls coincide by their anterior ends, and in their direction. The deviations of the rest of the contours (which represent the interior of the skulls only) show the differences of the skulls from one another, when these axes are regarded as relatively fixed lines.

The dark contours are those of an Australian and of a Negro

skull: the light contours are those of a Tartar skull, in the Museum of the Royal College of Surgeons; and of a well developed round skull from a cemetery in Constantinople, of uncertain race, in my own possession.

It appears, at once, from these views, that the prognathous skulls, so far as their jaws are concerned, do really differ from the orthognathous in much the same way as, though to a far less degree than, the skulls of the lower mammals differ from those of Man. Furthermore, the plane of the occipital foramen (*b c*) forms a somewhat smaller angle with the axis in these particular prognathous skulls than in the orthognathous; and the like may be slightly true of the perforated plate of the ethmoid — though this point is not so clear. But it is singular to remark that, in another respect, the prognathous skulls are less ape-like than the orthognathous, the cerebral cavity projecting decidedly more beyond the anterior end of the axis in the prognathous, than in the orthognathous, skulls.

It will be observed that these diagrams reveal an immense range of variation in the capacity and relative proportion to the cranial axis, of the different regions of the cavity which contains the brain, in the different skulls. Nor is the difference in the extent to which the cerebral overlaps the cerebellar cavity less singular. A round skull (Fig. 30, *Const.*) may have a greater posterior cerebral projection than a long one (Fig. 30, *Negro*).

Until human crania have been largely worked out in a manner similar to that here suggested — until it shall be an opprobrium to an ethnological collection to possess a single skull which is not bisected longitudinally — until the angles and measurements here mentioned, together with a number of others of which I cannot speak in this place, are determined, and tabulated with reference to the basicranial axis as unity, for large numbers of skulls of the different races of Mankind, I do not think we shall have any very safe basis for that ethnological craniology which aspires to give the anatomical characters of the crania of the different Races of Mankind.

At present, I believe that the general outlines of what may be safely said upon that subject may be summed up in a very few words. Draw a line on a globe, from the Gold Coast in Western Africa to the steppes of Tartary. At the southern and western end of that line there live the most dolichocephalic, prognathous, curly-haired, dark-skinned of men — the true Negroes. At the northern and eastern end of the same line there live the most brachycephalic, orthognathous, straight-haired, yellow-skinned of men — the Tartars and Calmucks. The two ends of this imag-

inary line are indeed, so to speak, ethnological antipodes. A line drawn at right angles, or nearly so, to this polar line through Europe and Southern Asia to Hindostan, would give us a sort of equator, around which round-headed, oval-headed, and oblong-headed, prognathous and orthognathous, fair and dark races — but none possessing the excessively marked characters of Calmuck or Negro — group themselves.

It is worthy of notice that the regions of the antipodal races are antipodal in climate, the greatest contrast the world affords, perhaps, being that between the damp, hot, steaming, alluvial coast plains of the West Coast of Africa and the arid, elevated steppes and plateaux of Central Asia, bitterly cold in winter, and as far from the sea as any part of the world can be.

From Central Asia eastward to the Pacific Islands and subcontinents on the one hand, and to America on the other, brachycephaly and orthognathism gradually diminish, and are replaced by dolichocephaly and prognathism, less, however, on the American Continent (throughout the whole length of which a rounded type of skull prevails largely, but not exclusively)* than in the Pacific region, where, at length, on the Australian Continent and in the adjacent islands, the oblong skull, the projecting jaws, and the dark skin reappear; with so much departure, in other respects, from the Negro type, that ethnologists assign to these people the special title of "Negritoes."

The Australian skull is remarkable for its narrowness and for the thickness of its walls, especially in the region of the supraciliary ridge, which is frequently, though not by any means invariably, solid throughout, the frontal sinuses remaining undeveloped. The nasal depression, again, is extremely sudden, so that the brows overhang and give the countenance a particularly lowering, threatening expression. The occipital region of the skull, also, not unfrequently becomes less prominent; so that it not only fails to project beyond a line drawn perpendicular to the hinder extremity of the glabello-occipital line, but even, in some cases, begins to shelve away from it, forwards, almost immediately. In consequence of this circumstance, the parts of the occipital bone which lie above and below the tuberosity make a much more acute angle with one another than is usual, whereby the hinder part of the base of the skull appears obliquely truncated. Many Australian skulls have a considerable height, quite equal to that of the average of any other race, but there are others in which the cranial roof becomes remarkably depressed, the skull, at the same

* See Dr. D. Wilson's valuable paper "On the supposed prevalence of one Cranial Type throughout the American Aborigines."—*Canadian Journal*, Vol. II.

time, elongating so much that, probably, its capacity is not diminished. The majority of skulls possessing these characters, which I have seen, are from the neighbourhood of Port Adelaide in South Australia, and have been used by the natives as water vessels; to which end the face has been knocked away, and a string passed through the vacuity and the occipital foramen, so that the skull was suspended by the greater part of its basis.

Fig. 31 represents the contour of a skull of this kind from Western Port, with the jaw attached, and of the Neanderthal skull, both reduced to one-third of the size of nature. A small additional amount of flattening and lengthening, with a corresponding increase of the supraciliary ridge, would convert the Aus-

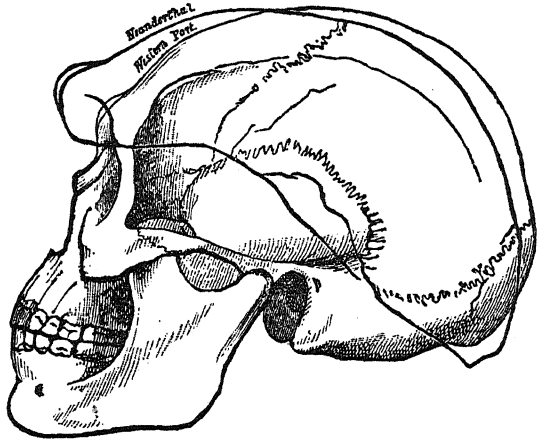


Fig. 31.—An Australian skull from Western Port, in the Museum of the Royal College of Surgeons, with the contour of the Neanderthal skull. Both reduced to one-third the natural size.

tralian brain case into a form identical with that of the aberrant fossil.

And now, to return to the fossil skulls, and to the rank which they occupy among, or beyond, these existing varieties of cranial conformation. In the first place, I must remark, that, as Professor Schmerling well observed (*supra*, p. 92) in commenting upon the Engis skull, the formation of a safe judgment upon the question is greatly hindered by the absence of the jaws from both the crania, so that there is no means of deciding, with certainty, whether they were more or less prognathous than the lower existing races of mankind. And yet, as we have seen, it is more in

this respect than any other, that human skulls vary, towards and from, the brutal type — the brain case of an average dolichocephalic European differing far less from that of a Negro, for example, than his jaws do. In the absence of the jaws, then, any judgment on the relations of the fossil skulls to recent Races must be accepted with a certain reservation.

But taking the evidence as it stands, and turning first to the Engis skull, I confess I can find no character in the remains of that cranium which, if it were a recent skull, would give any trustworthy clue as to the Race to which it might appertain. Its contours and measurements agree very well with those of some Australian skulls which I have examined — and especially has it a tendency towards that occipital flattening, to the great extent of which, in some Australian skulls, I have alluded. But all Australian skulls do not present this flattening, and the supraciliary ridge of the Engis skull is quite unlike that of the typical Australians.

On the other hand, its measurements agree equally well with those of some European skulls. And assuredly, there is no mark of degradation about any part of its structure. It is, in fact, a fair average human skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage.

The case of the Neanderthal skull is very different. Under whatever aspect we view this cranium, whether we regard its vertical depression, the enormous thickness of its supraciliary ridges, its sloping occiput, or its long and straight squamosal suture, we meet with ape-like characters, stamping it as the most pithecoid of human crania yet discovered. But Professor Schaaffhausen states (*supra*, p. 99), that the cranium, in its present condition, holds 1033.24 cubic centimetres of water, or about 63 cubic inches, and as the entire skull could hardly have held less than an additional 12 cubic inches, its capacity may be estimated at about 75 cubic inches, which is the average capacity given by Morton for Polynesian and Hottentot skulls.

So large a mass of brain as this would alone suggest that the pithecoid tendencies indicated by this skull did not extend deep into the organization; and this conclusion is borne out by the dimensions of the other bones of the skeleton given by Professor Schaaffhausen which shows that the absolute height and relative proportions of the limbs, were quite those of an European of middle stature. The bones are indeed stouter, but this and the great development of the muscular ridges noted by Dr. Schaaffhausen, are characters to be expected in savages. The Patagonians, exposed without shelter or protection to a climate possibly

not very dissimilar from that of Europe at the time during which the Neanderthal man lived, are remarkable for the stoutness of their limb bones.

In no sense, then, can the Neanderthal bones be regarded as the remains of a human being intermediate between Men and Apes.

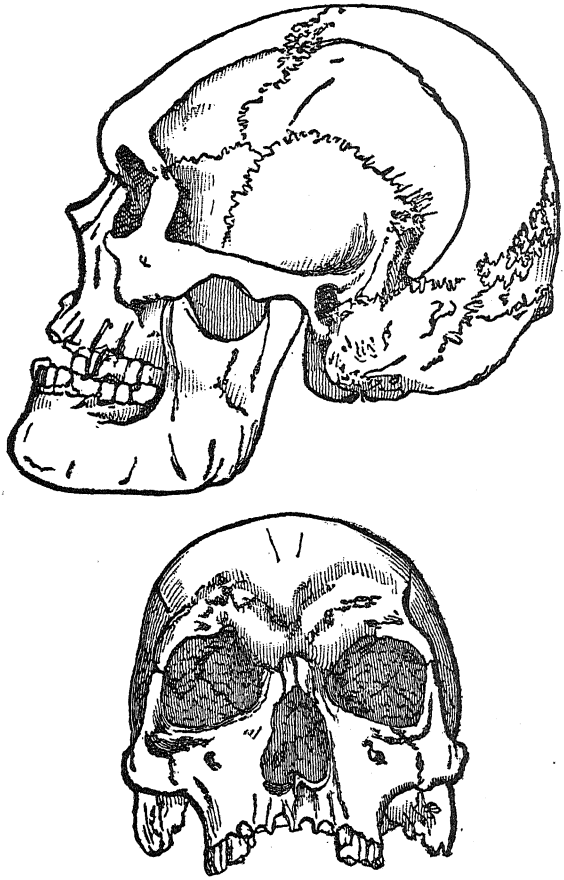


Fig. 32.—Ancient Danish skull from a tumulus at Borreby; one-third of the natural size. From a camera lucida drawing by Mr. Busk.

At most, they demonstrate the existence of a Man whose skull may be said to revert somewhat towards the pithecoid type — just as a Carrier, or a Pouter, or a Tumbler, may sometimes put on the plumage of its primitive stock, the *Columba livia*. And in-

deed, though truly the most pithecoid of known human skulls, the Neanderthal cranium is by no means so isolated as it appears to be at first, but forms, in reality, the extreme term of a series leading gradually from it to the highest and best developed of human crania. On the one hand, it is closely approached by the flattened Australian skulls, of which I have spoken, from which other Australian forms lead us gradually up to skulls having very much the type of the Engis cranium. And, on the other hand, it is even more closely affined to the skulls of certain ancient people who inhabited Denmark during the "stone period," and were probably either contemporaneous with, or later than, the makers of the "refuse heaps," or "Kjokkenmöddings" of that country.

The correspondence between the longitudinal contour of the Neanderthal skull and that of some of those skulls from the tumuli at Borreby, very accurate drawings of which have been made by Mr. Busk, is very close. The occiput is quite as retreating, the supraciliary ridges are nearly as prominent, and the skull is as low. Furthermore, the Borreby skull resembles the Neanderthal form more closely than any of the Australian skulls do, by the much more rapid retrocession of the forehead. On the other hand, the Borreby skulls are all somewhat broader, in proportion to their length, than the Neanderthal skull, while some attain that proportion of breadth to length (80 : 100) which constitutes brachycephaly.*

In conclusion, I may say, that the fossil remains of Man hitherto discovered do not seem to me to take us appreciably nearer to that lower pithecoid form, by the modification of which he has, probably, become what he is. And considering what is now known of the most ancient Races of men; seeing that they fashioned flint axes and flint knives and bone-skewers, of much the same pattern as those fabricated by the lowest savages at the present day, and that we have every reason to believe the habits and modes of living of such people to have remained the same from the time of the Mammoth and the tichorhine Rhinoceros till now, I do not know that this result is other than might be expected.

[* For a further discussion of the characters of the Neanderthal skull, see "Natural History Review," 1864. I there say (p. 443): "That the Neanderthal skull exhibits the lowest type of human cranium at present known, so far as it presents certain pithecoid characters in a more exaggerated form than any other: but that, inasmuch as a complete series of gradations can be found, among recent human skulls, between it and the best developed forms, there is no ground for separating its possessor specifically, still less generically, from *Homo sapiens*. At present, we have no sufficient warranty for declaring it to be either the type of a distinct race, or a member of any existing one; nor do the anatomical characters of the skull justify any conclusion as to the age to which it belongs." See also the essay on the Aryan question in this volume. 1894.]

Where, then, must we look for primæval Man? Was the oldest *Homo sapiens* pliocene or miocene, or yet more ancient? In still older strata do the fossilized bones of an ape more anthropoid, or a Man more pithecoid, than any yet known await the researches of some unborn paleontologist?

Time will show. But, in the meanwhile, if any form of the doctrine of progressive development is correct, we must extend by long epochs the most liberal estimate that has yet been made of the antiquity of Man.

IV.

ON THE METHODS AND RESULTS OF ETHNOLOGY.

ETHNOLOGY is the science which determines the distinctive characters of the persistent modifications of mankind; which ascertains the distribution of those modifications in present and past times, and seeks to discover the causes, or conditions of existence, both of the modifications and of their distribution. I say "persistent" modifications, because, unless incidentally, ethnology has nothing to do with chance and transitory peculiarities of human structure. And I speak of "persistent modifications" or "stocks" rather than of "varieties," or "races," or "species," because each of these last well-known terms implies on the part of its employer, a preconceived opinion touching one of those problems, the solution of which is the ultimate object of the science; and in regard to which, therefore, ethnologists are especially bound to keep their minds open and their judgments freely balanced.

Ethnology, as thus defined, is a branch of ANTHROPOLOGY, the great science which unravels the complexities of human structure; traces out the relations of man to other animals; studies all that is especially human in the mode in which man's complex functions are performed; and searches after the conditions which have determined his presence in the world. And anthropology is a section of ZOOLOGY, which again is the animal half of BIOLOGY — the science of life and living things.

Such is the position of ethnology, such are the objects of the ethnologist. The paths or methods, by following which he may hope to reach his goal, are diverse. He may work at man from the point of view of the pure zoologist, and investigate the anatomical and physiological peculiarities of Negroes, Australians, or Mongolians, just as he would inquire into those of pointers, terriers, and turnspits,— "persistent modifications" of man's almost universal companion. Or he may seek aid from researches into the most human manifestation of humanity — Language; and assuming that what is true of speech is true of the speaker — a hy-

pothesis as questionable in science as it is in ordinary life — he may apply to mankind themselves the conclusions drawn from a searching analysis of their words and grammatical forms.

Or, the ethnologist may turn to the study of the practical life of men; and relying upon the inherent conservatism and small inventiveness of untutored mankind, he may hope to discover in manners and customs, or in weapons, dwellings, and other handiwork, a clue to the origin of the resemblances and differences of nations. Or, he may resort to that kind of evidence which is yielded by History proper, and consists of the beliefs of men concerning past events, embodied in traditional, or in written testimony. Or, when that thread breaks, Archæology, which is the interpretation of the unrecorded remains of man's works, belonging to the epoch since the world has reached its present condition, may still guide him. And, when even the dim light of archæology fades, there yet remains Palæontology, which, in these latter years has brought to daylight once more the exuvia of ancient populations, whose world was not our world, who have been buried in river beds immemorially dry, or carried by the rush of waters into caves, inaccessible to inundation since the dawn of tradition.

Along each, or all, of these paths the ethnologist may press towards his goal; but they are not equally straight, or sure, or easy to tread. The way of palæontology has but just been laid open to us. Archæological and historical investigations are of great value for all those peoples whose ancient state has differed widely from their present condition, and who have the good or evil fortune to possess a history. But on taking a broad survey of the world, it is astonishing how few nations present either condition. Respecting five-sixths of the persistent modifications of mankind, history and archæology are absolutely silent. For half the rest, they might as well be silent for anything that is to be made of their testimony. And, finally, when the question arises as to what was the condition of mankind more than a paltry two or three thousand years ago, history and archæology are, for the most part, mere dumb dogs. What light does either of these branches of knowledge throw on the past of the man of the New World, if we except the Central Americans and the Peruvians; on that of the Africans, save those of the Valley of the Nile and a fringe of the Mediterranean; on that of all the Polynesian, Australian, and central Asiatic peoples, the former of whom probably, and the last certainly, were, at the dawn of history, substantially what they are now? While thankfully accept-

ing what history has to give him, therefore, the ethnologist must not look for too much from her.

Is more to be expected from inquiries into the customs and handicrafts of man? It is to be feared not. In reasoning from identity of custom to identity of stock the difficulty always obtrudes itself, that the minds of men being everywhere similar, differing in quality and quantity but not in kind of faculty, like circumstances must tend to produce like contrivances; at any rate, so long as the need to be met and conquered is of a very simple kind. That two nations use calabashes or shells for drinking-vessels, or that they employ spears, or clubs, or swords and axes of stone and metal as weapons and implements, cannot be regarded as evidence that these two nations had a common origin, or even that intercommunication ever took place between them; seeing that the convenience of using calabashes or shells for such purposes, and the advantage of poking an enemy with a sharp stick, or hitting him with a heavy one, must be early forced by nature upon the mind of even the stupidest savage. And when he had found out the use of a stick, he would need no prompting to discover the value of a chipped or whetted stone, or of an angular piece of native metal, for the same object. On the other hand, it may be doubted, whether the chances are not greatly against independent peoples arriving at the manufacture of a boomerang, or of a bow; which last, if one comes to think of it, is a rather complicated apparatus; and the tracing of the distribution of inventions as complex as these, and of such strange customs as betel-chewing and tobacco-smoking, may afford valuable ethnological hints.

Since the time of Leibnitz, and guided by such men as Humboldt, Abel Remusat, and Klaproth, Philology has taken far higher ground. Thus Prichard affirms that "the history of nations, termed Ethnology, must be mainly founded on the relations of their languages."

An eminent living philologer, August Schleicher, in a recent essay, puts forward the claims of his science still more forcibly:—

"If, however, language is the human κατ' ἐξοχήν, the suggestion arises whether it should not form the basis of any scientific systematic arrangement of mankind; whether the foundation of the natural classification of the genus Homo has not been discovered in it.

"How little constant are cranial peculiarities and other so-called race characters! Language, on the other hand, is always a perfectly constant diagnostic. A German may occasionally compete in hair and prognathism with a negro, but a negro language will never be his mother tongue. Of how little importance for mankind the so-called race char-

acters are, is shown by the fact that speakers of languages belonging to one and the same linguistic family may exhibit the peculiarities of various races. Thus the settled Osmanli Turk exhibits Caucasian characters, whilst other so-called Tartaric Turks exemplify the Mongol type. On the other hand, the Magyar and the Basque do not depart in any essential physical peculiarity from the Indo-Germans, whilst the Magyar, Basque, and Indo-Germanic tongues are widely different. Apart from their inconstancy, again, the so-called race characters can hardly yield a scientifically natural system. Languages, on the other hand, readily fall into a natural arrangement, like that of which other vital products are susceptible, especially when viewed from their morphological side. . . . The externally visible structure of the cerebral and facial skeletons, and of the body generally, is less important than that no less material but infinitely more delicate corporeal structure, the function of which is speech. I conceive, therefore, that the natural classification of languages, is also the natural classification of mankind. With language, moreover, all the higher manifestations of man's vital activity are closely interwoven, so that these receive due recognition in and by that of speech."*

Without the least desire to depreciate the value of philology as an adjuvant to ethnology, I must venture to doubt, with Rudolphi, Desmoulins, Crawfurd, and others, its title to the leading position claimed for it by the writers whom I have just quoted. On the contrary, it seems to me obvious that, though, in the absence of any evidence to the contrary, unity of languages may afford a certain presumption in favour of the unity of stock of the peoples speaking those languages, it cannot be held to prove that unity of stock, unless philologers are prepared to demonstrate, that no nation can lose its language and acquire that of a distinct nation, without a change of blood corresponding with the change of language. Desmoulins long ago put this argument exceedingly well: —

"Let us imagine the recurrence of one of those slow, or sudden, political revolutions, or say of those secular changes which among different people and at different epochs have annihilated historical monuments and even extinguished tradition. In that case, the evidence, now so clear, that the negroes of Hayti were slaves imported by a French colony, who, by the very effect of the subordination involved in slavery lost their own diverse languages and adopted that of their masters, would vanish. And metaphysical philosophers, observing the identity of Haytian French with that spoken on the shores of the Seine and the Loire, would argue that the men of St. Domingo with woolly heads, black and oily skins, small calves, and slightly bent knees, are of the same race, descended from the same parental stock, as the Frenchmen with silky brown, chestnut, or fair hair, and white skins. For they

* August Schleicher. *Ueber die Bedeutung der Sprache für die Naturgeschichte des Menschen*, pp. 16-18.

would say, their languages are more similar than French is to German or Spanish."*

It must not be imagined that the case put by Desmoulins is a merely hypothetical one. Events precisely similar to the transport of a body of Africans to the West India Islands, indeed cannot have happened among uncivilised races, but similar results have followed the importation of bodies of conquerors among an enslaved people over and over again. There is hardly a country in Europe in which two or more nations speaking widely different tongues have not become intermixed; and there is hardly a language of Europe of which we have any right to think that its structure affords a just indication of the amount of that intermixture.

As Dr. Latham has well said:—

"It is certain that the language of England is of Anglo-Saxon origin, and that the remains of the original Keltic are unimportant. It is by no means so certain that the blood of Englishmen is equally Germanic. A vast amount of Kelticism, not found in our tongue, very probably exists in our pedigrees. The ethnology of France is still more complicated. Many writers make the Parisian a Roman on the strength of his language; whilst others make him a Kelt on the strength of certain moral characteristics, combined with the previous Kelticism of the original Gauls. Spanish and Portuguese, as languages, are derivations from the Latin; Spain and Portugal, as countries, are Iberic, Latin, Gothic, and Arab, in different proportions. Italian is modern Latin all the world over; yet surely there must be much Keltic blood in Lombardy, and much Etruscan intermixture in Tuscany.

"In the ninth century every man between the Elbe and the Niemen spoke some Slavonic dialect; they now nearly all speak German. Surely the blood is less exclusively Gothic than the speech.†

In other words, what philologer, if he had nothing but the vocabulary and grammar of the French and English languages to guide him, would dream of the real causes of the unlikeness of a Norman to a Provençal, of an Orcadian to a Cornishman? How readily might he be led to suppose that the different climatal conditions to which these speakers of one tongue have so long been exposed, have caused their physical differences; and how little would he suspect that these are due (as we happen to know they are) to wide differences of blood.

Few take duly into account the evidence which exists as to the ease with which unlettered savages gain or lose a language. Captain Erskine, in his interesting "Journal of a Cruise among the

* Desmoulins, *Histoire Naturelle des Races Humaines*, p. 345.
† Latham, *Man and his Migrations*, p. 171.

Islands of the Western Pacific," especially remarks upon the "avidity with which the inhabitants of the polyglot islands of Melanesia, from New Caledonia to the Solomon Islands, adopt the improvements of a more perfect language than their own, which different causes and accidental communication still continue to bring to them;" and he adds that "among the Melanesian islands scarcely one was found by us which did not possess, in some cases still imperfectly, the decimal system of numeration in addition to their own, in which they reckon only to five."

Yet how much philological reasoning in favour of the affinity or diversity of two distinct peoples has been based on the mere comparison of numerals!

But the most instructive example of the fallacy which may attach to merely philological reasonings, is that afforded by the Feejeans, who are, physically, so intimately connected with the adjacent Negritos of New Caledonia, &c., that no one can doubt to what stock they belong, and who yet, in the form and substance of their language, are Polynesian. The case is as remarkable as if the Canary Islands should have been found to be inhabited by negroes speaking Arabic, or some other clearly Semitic dialect, as their mother tongue. As it happens, the physical peculiarities of the Feejeans are so striking, and the conditions under which they live are so similar to those of the Polynesians, that no one has ventured to suggest that they are merely modified Polynesians — a suggestion which could otherwise certainly have been made. But if languages may be thus transferred from one stock to another, without any corresponding intermixture of blood, what ethnological value has philology? — what security does unity of language afford us that the speakers of that language may not have sprung from two, or three, or a dozen, distinct sources?

Thus we come, at last, to the purely zoological method, from which it is not unnatural to expect more than from any other, seeing that, after all, the problems of ethnology are simply those which are presented to the zoologist by every widely distributed animal he studies. The father of modern zoology seems to have had no doubt upon this point. At the twenty-eighth page of the standard twelfth edition of the "Systema Naturæ," in fact, we find: —

I. PRIMATES.

Dentes primores incisores: superiores IV. paralleli, mammæ pectorales II.

1. HOMO.	Nosce te ipsum.
Sapiens.	1. H. diurnus: *varians cultura, loco.*
Ferus.	Tetrapus, mutus, hirsutus.

.

Americanus α. Rufus, cholericus, rectus — *Pilis* nigris, rectis, crassis — *Naribus* patulis — *Facie* ephelitica: *Mento* subimberbi. *Pertinax*, contentus, liber. *Pingit* se lineis dædaleis rubris.
Regitur Consuetudine.

Europæus β. Albus sanguineus torosus. *Pilis* flavescentibus, prolixis. *Oculis* cœruleis.
Levis, argutus, inventor. *Tegitur* Vestimentis arctis. *Regitur* Ritibus.

Asiaticus γ. Luridus, melancholicus, rigidus. *Pilis* nigricantibus. *Oculis* fuscis. *Severus*, fastuosus, avarus. *Tegitur* Indumentis laxis.
Regitur Opinionibus.

Afer δ. Niger, phlegmaticus, laxus. *Pilis* atris, contortuplicatis. *Cute* holosericea. *Naso* simo. *Labiis* tumidis. *Feminis* sinus pudoris.
Mammæ lactantes prolixæ.
Vafer, segnis, negligens. *Ungit* se pingui. *Regitur* Arbitrio.

Monstrosus ε. Solo (a) et arte (b c) variat.:
a. *Alpini* parvi, agiles, timidi.
Patagonici magni, segnes.
b. *Monorchides* ut minus fertiles: Hottentotti.
Junceæ puellæ, abdomine attenuato: Europææ.
c. *Macrocephali* capiti conico: Chinenses.
Plagiocephali capite antice compresso: Canadenses.

Turn a few pages further on in the same volume, and there appears, with a fine impartiality in the distribution of capitals and subdivisional headings:—

III. FERAE.

Dentes primores superiores sex, acutiusculi. Canini solitarii.

.

12. CANIS. *Dentes primores* superiores VI.: laterales longiores distantes: intermedii lobati. Inferiores VI.: laterales lobati.
Laniarii solitarii, incurvati.
Molares VI. s VII. (pluresve quam in reliquis.)

familiaris 1. C. cauda (sinistrorsum) recurvata.....
domesticus α. auriculis erectis, cauda subtus lanata.
sagax β. auriculis pendulis, digito spurio ad tibias posticas.
grajus γ. magnitudine lupi, trunco curvato, rostro attenuato, &c. &c.

Linnæus' definition of what he considers to be mere varieties of the species Man are, it will be observed, as completely free from any allusion to linguistic peculiarities as those brief and pregnant sentences in which he sketches the characters of the varieties of

the species Dog. "Pilis nigris, naribus patulis" may be set against "auriculis erectis, cauda subtus lanata;" while the remarks on the morals and manners of the human subject seem as if they were thrown in merely by way of makeweight.

Buffon, Blumenbach (the founder of ethnology as a special science), Rudolphi, Bory de St. Vincent, Desmoulins, Cuvier, Retzius, indeed I may say all the naturalists proper, have dealt with man from a no less completely zoological point of view; while, as might have been expected, those who have been least naturalists, and most linguists, have most neglected the zoological method, the neglect culminating in those who have been altogether devoid of acquaintance with anatomy.

Prichard's proposition, that language is more persistent than physical characters, is one which has never been proved, and indeed admits of no proof, seeing that the records of language do not extend so far as those of physical characters. But until the superior tenacity of linguistic over physical peculiarities is shown, and until the abundant evidence which exists, that the language of a people may change without corresponding physical change in that people, is shown to be valueless, it is plain that the zoological court of appeal is the highest for the ethnologist, and that no evidence can be set against that derived from physical characters.

What, then, will a new survey of mankind from the Linnean point of view teach us?

The great antipodal block of land we call Australia has, speaking roughly, the form of a vast quadrangle, 2,000 miles on the side, and extends from the hottest tropical, to the middle of the temperate, zone. Setting aside the foreign colonists introduced within the last century, it is inhabited by people no less remarkable for the uniformity, than for the singularity, of their physical characters and social state. For the most part of fair stature, erect and well built, except for an unusual slenderness of the lower limbs, the AUSTRALIANS have dark, usually chocolate-coloured skins; fine dark wavy hair; dark eyes, overhung by beetle brows; coarse, projecting jaws; broad and dilated, but not especially flattened, noses, and lips which, though prominent, are eminently flexible.

The skulls of these people are always long and narrow, with a smaller development of the frontal sinuses than usually corresponds with such largely developed brow ridges. An Australian skull of a round form, or one the transverse diameter of which exceeds eight-tenths of its length, has never been seen. These people,

in a word, are eminently "dolichocephalic," or long-headed; but, with this one limitation, their crania present considerable variations, some being comparatively high and arched, while others are more remarkably depressed than almost any other human skulls. The female pelvis differs comparatively little from the European; but in the pelves of male Australians which I have examined, the antero-posterior and transverse diameters approach equality more nearly than is the case in Europeans.

No Australian tribe has ever been known to cultivate the ground,* to use metals, pottery, or any kind of textile fabric. They rarely construct huts. Their means of navigation are limited to rafts or canoes, made of sheets of bark. Clothing, except skin cloaks for protection from cold, is a superfluity with which they dispense; and though they have some singular weapons, almost peculiar to themselves, they are wholly unacquainted with bows and arrows.

It is but a step, as it were, across Bass's Straits to Tasmania. Neither climate nor the characteristic forms of vegetable or animal life change largely on the south side of the Straits, but the early voyagers found Man singularly different from him on the north side. The skin of the Tasmanian was dark, though he lived between parallels of latitude corresponding with those of middle Europe in our own hemisphere; his jaws projected, his head was long and narrow; his civilization was about on a footing with that of the Australian, if not lower, for I cannot discover that the Tasmanian understood the use of the throwing-stick. But he differed from the Australian in his woolly negro-like hair; whence the name of NEGRITO, which has been applied to him and his congeners.

Such Negritos — differing more or less from the Tasmanian but agreeing with him in dark skin and woolly hair — occupy New Caledonia, the New Hebrides, the Louisiade Archipelago; and stretching to the Papuan Islands, and for a doubtful extent beyond them to the north and west, from a sort of belt, or zone, of Negrito population, interposed between the Australians on the west and the inhabitants of the great majority of the Pacific islands on the east.

The cranial characters of the Negritos vary considerably more than those of their skin and hair, the most notable circumstance being the strong Australian aspect which distinguishes many

[* At Cape York we found that the natives had learned from their Papuan neighbours to grow a little coarse tobacco; and, elsewhere, yams are said to be grown, but hardly cultivated. Plaiting, basket-making, and netting are practised.— 1894.]

Negrito skulls, while others tend rather towards forms common in the Polynesian islands.

In civilisation, New Caledonia exhibits an advance upon Tasmania, and, farther north, there is a still greater improvement. But the bows and arrows, the perched houses, the outrigger canoes, the habits of betel-chewing and of kawa-drinking, which abound more or less among the northern Negritos, are probably to be regarded not as the products of an indigenous civilization, but merely as indications of the extent to which foreign influences have modified the primitive social state of these people.

From Tasmania or New Caledonia, to New Zealand or Tongataboo, is again but a brief voyage: but it brings about a still more notable change in the aspect of the indigenous population than that effected by the passage of Bass's Straits. Instead of being chocolate-coloured people, the Maories and Tongans are light brown; instead of woolly, they have straight, or wavy, black hair. And if from New Zealand, we travel some 5,000 miles east to Easter Island; and from Easter Island, for as great a distance north-west, to the Sandwich Islands; and thence 7,000 miles, westward and southward, to Sumatra; and even across the Indian Ocean, into the interior of Madagascar, we shall everywhere meet with people whose hair is straight or wavy, and whose skins exhibit various shades of brown. These are the Polynesians, Micronesians, Indonesians, whom Latham has grouped together under the common title of AMPHINESIANS.

The cranial characters of these people, as of the Negritos, are less constant than those of their skin and hair. The Maori has a long skull; the Sandwich Islander a broad skull. Some, like these, have strong brow ridges; others like the Dayaks and many Polynesians, have hardly any nasal indentation. It is only in the westernmost parts of their area that the Amphinesian nations know anything about bows and arrows as weapons, or are acquainted with the use of metals or with pottery. Everywhere they cultivate the ground, construct houses, and skilfully build and manage outrigger, or double canoes; while, almost everywhere, they use some kind of fabric for clothing.

Between Easter Island, or the Sandwich Islands, and any part of the American coast is a much wider interval than that between Tasmania and New Zealand, but the ethnological interval between the American and the Polynesian is less than that between either of the previously named stocks.

The typical AMERICAN has straight black hair and dark eyes, his skin exhibiting various shades of reddish or yellowish brown, sometimes inclining to olive. The face is broad and scantily

bearded; the skull wide and high. Such people extend from Patagonia to Mexico, and much farther north along the west coast. In the main a race of hunters, they had nevertheless, at the time of the discovery of the Americas, attained a remarkable degree of civilization in some localities. They had domesticated ruminants, and not only practised agriculture, but had learned the value of irrigation. They manufactured textile fabrics, were masters of the potter's art, and knew how to erect massive buildings of stone. They understood the working of the precious, though not of the useful, metals;* and had even attained to a rude kind of hieroglyphic, or picture, writing. The Americans not only employ the bow and arrow, but, like some Amphinesians, the blow-pipe, as offensive weapons: but I am not aware that the outrigger canoe has ever been observed among them.

I have reason to suspect that some of the Fuegian tribes differ cranially from the typical Americans;† and the Northern and Eastern American tribes have longer skulls than their southern compatriots. But the ESQUIMAUX, who roam on the desolate and ice-bound coast of Arctic America, certainly present us with a new stock. The Esquimaux (among whom the Greenlanders are included), in fact, though they share the straight black hair of the proper Americans, are generally a duller complexioned, shorter, and a more squat people, and they have still more prominent cheek-bones. But the circumstance which most completely separates them from the typical Americans, is the form of their skulls, which instead of being broad, high, and truncated behind, are eminently long, usually low, and prolonged backwards. These Hyperborean people clothe themselves in skins, know nothing of pottery, and hardly anything of metals. Dependent for existence upon the produce of the chase, the seal and the whale are to them what the cocoa-nut tree and the plantain are to the savages of more genial climates. Not only are those animals meat and raiment, but they are canoes, sledges, weapons, tools, windows, and fire; while they support the dog, who is the indispensable ally and beast of burden of the Esquimaux.

It is admitted that the Tchuktchi, on the eastern side of Behring's Straits, are, in all essential respects, Esquimaux; and I do not know that there is any satisfactory evidence to show that the Tunguses and Samoiedes do not essentially share the same physical characters. Southward, there are indications of Esquimaux characters among the Japanese, and it is possible that their influence may be traced yet further.

[* With the exception of copper and bronze.— 1894.]

[† A suspicion subsequently verified. See a memoir on American Skulls, *Journal of Anatomy and Physiology.* Vol. 16.— 1894.]

However this may be, Eastern Asia, from Mantchouria to Siam, Thibet, and Northern Hindostan, is continuously inhabited by men, usually of short stature, with skins varying in colour from yellow to olive; with broad chèek-bones and faces that, owing to the insignificance of the nose, are exceedingly flat; and with small, obliquely-set * black eyes and straight black hair, which sometimes attains a very great length upon the scalp, but is always scanty upon the face and body. The skull, never much elongated, is, generally, remarkably broad and rounded, with hardly any nasal depression, and but slight, if any, projection of the jaws. Many of these people, from whom the old name of MONGOLIANS may be retained, are nomades; others, as the Chinese, have attained a remarkable and apparently indigenous civilization, only surpassed by that of Europe.

At the north-western extremity of Europe the Lapps repeat the characters of the Eastern Asiatics. Between these extreme points, the Mongolian stock is not continuous, but is represented by a chain of more or less isolated tribes, who pass under the name of Calmucks and Tartars, and form Mongolian islands, as it were, in the midst of an ocean of other people.

The waves of this ocean are the nations for whom, in order to avoid the endless confusion produced by our present half-physical, half-philological classification, I shall use a new name — XANTHOCHROI — indicating that they are "yellow" haired and "pale" in complexion. The Chinese historians of the Han dynasty, writing in the third century before our era, describe, with much minuteness, certain numerous and powerful barbarians with "yellow hair, green eyes, and prominent noses," who, the black-haired, skew-eyed, and flat-nosed annalists remark in passing, are "just like the apes from whom they are descended." These people held in force, the upper waters of the Yenisei, and thence under various names stretched southward to Thibet and Kashgar. Fair-haired and blue-eyed northern enemies were no less known to the ancient Hindoos, to the Persians, and to the Egyptians, on the south and west of the great central Asiatic area; while the testimony of all European antiquity is to the effect that, before and since the period in question, there lay beyond the Danube, the Rhine, and the Seine, a vast and dangerous yellow or red-haired, fair-skinned, blue-eyed population. Whether the disturbers of the marches of the Roman Empire were called Gauls or Germans, Goths, Alans, or Scythians, one thing seems certain, that until the invasion of the Huns, they were largely tall, fair, blue-eyed men.

[* The obliquity, it must be recollected, is not in the position of the eyeball but arises from the arrangement of the skin in the neighbourhood of the eyelids.— 1894.]

If any one should think fit to assume that, in the year 100 B. C., there was one continuous Xanthochroic population from the Rhine to the Yenisei, and from the Ural mountains to the Hindoo Koosh, I know not that any evidence exists by which that position could be upset, while the existing state of things is rather in its favour than otherwise. For the Scandinavians, the Germans, the Slavonian and the Finnish tribes, to a great extent; some of the inhabitants of Greece, many Turks, some Kirghis, and some Mantchous, the Ossetes in the Caucasus, the Siahposh, the Rohillas, are at the present day fair, yellow or red-haired, and blue-eyed; and the interpolation of tribes of Mongolian hair and complexion, as far west as the Caspian Steppes and the Crimea, might justly be accounted for by those subsequent westward irruptions of the Mongolian stock, of which history furnishes abundant testimony. The furthermost limit of the Xanthochroi north-westward is Iceland and the British Isles; south-westward, they are traceable at intervals through Syria and the Berber country, ending in the Canary Islands. The cranial characters of the Xanthochroi are not, at present, strictly definable. The Scandinavians are certainly long-headed; but many Germans, the Swiss so far as they are Germanized, the Slavonians, the Fins, and the Turks, are short-headed. What were the cranial characters of the ancient "Usuns" and "Ting-lings" of the valley of the Yenisei is unknown.

West and south of the area occupied by the chief mass of the Xanthochroi, and north of the Sahara, is a broad belt of land, shaped like a ≻. Between the forks of the Y lies the Mediterranean; the stem of it is Arabia. The stem is bathed by the Indian Ocean, the western ends of the forks by the Atlantic. The majority of the people inhabiting the area thus roughly defined have, like the Xanthochroi, prominent noses, pale skins and wavy hair, with abundant beards; but, unlike them, the hair is black or dark and the eyes usually so. They may thence be called the MELANOCHROI. Such people are found in the British Islands, in Western and Southern Gaul, in Spain, in Italy south of the Po, in parts of Greece, in Syria, and Arabia, stretching as far northward and eastward as the Caucasus and Persia. They are the chief inhabitants of Africa north of the Sahara, and like the Xanthochroi, they end in the Canary Islands. They are known as Kelts, Iberians, Etruscans, Romans, Pelasgians, Berbers, Semites. The majority of them are long-headed, and of smaller stature than the Xanthochroi.* It is needless to remark upon the civilization of

[* See the Essay on the Aryan Question, in this volume, for some qualifications of these statements necessitated by further knowledge.—1894.]

these two great stocks. With them has originated everything that is highest in science, in art, in law, in politics, and in mechanical inventions. In their hands, at the present moment, lies the order of the social world, and to them its progress is committed.

South of the Atlas, and of the Great Desert, Middle Africa exhibits a new type of humanity in the NEGRO, with his dark skin, woolly hair, projecting jaws, and thick lips. As a rule, the skull of the Negro is remarkably long; it rarely approaches the broad type, and never exhibits the roundness of the Mongolian. A cultivator of the ground, and dwelling in villages; a maker of pottery, and a worker in the useful as well as the ornamental metals; employing the bow and arrow as well as the spear, the typical negro stands high in point of civilization above the Australian.

Resembling the Negroes in cranial characters, the BUSHMEN of South Africa differ from them in their yellowish brown skins, their tufted hair, their remarkably small stature, and their tendency to fatty and other integumentary outgrowths; nor is the wonderful click with which their speech is interspersed to be overlooked in enumerating the physical characteristics of this strange people.

The so-called "Dravidian" populations of Southern Hindostan lead us back, physically as well as geographically, towards the Australians;* while the diminutive MINCOPIES of the Andaman Islands lie midway between the Negro and Negrito races, and, as Mr. Busk has pointed out, occasionally present the rare combination of brachycephaly, or short-headedness, with woolly hair.

In the preceding progress along the outskirts of the habitable world, eleven readily distinguishable stocks, or persistent modifications, of mankind, have been recognized. I have purposely omitted such people as the Abyssinians and the Hindoos of the valleys of the Ganges and Indus, who there is every reason to believe result from the intermixture of distinct stocks. Perhaps I ought for like reasons, to have ignored the Mincopies. But I do not pretend that my enumeration is complete, or, in any sense, perfect. It is enough for my purpose if it be admitted (and I

[* Of the affinities of these stocks I think there can be no doubt. I was formerly inclined to believe that the ancient Egyptian was the highest term in an ascending series: Australian — Dravidian — Egyptian of allied stocks. And I believe still that there is a good deal to be said for that hypothesis. One of the most interesting problems at present is the relation of the præsemitic population of Babylonia to the Dravidians, on the one hand, and the Old Egyptian on the other. Only one point appears to me to be quite clear, if the statues of Tell Loh represent these people; that there is not a trace of Mongolian affinity about them.— 1894.]

think it cannot be denied) that those which I have mentioned exist, are well marked, and occupy the greater part of the habitable globe.

In attempting to classify these persistent modifications after the manner of naturalists, the first circumstance that attracts one's attention is the broad contrast between the people with straight and wavy hair, and those with crisp, woolly, or tufted hair. Bory de St. Vincent, noting this fundamental distinction, divided mankind accordingly into the two primary groups of *Leiotrichi* and *Ulotrichi*,— terms which are open to criticism, but which I adopt in the accompanying table, because they have been used. It is better for science to accept a faulty name which has the merit of existence, than to burthen it with a faultless newly invented one.

LEIOTRICHI.			ULOTRICHI.	
Dolichocephali.	Brachycephali.		Dolichocephali.	Brachycephali.
Leucous.				
....Xanthochroi....				
Leucomelanous.				
....Melanochroi....				
Xanthomelanous.				
Esquimaux.	Mongolians.		*Bushmen.*	
	Amphinasians.			
Melanous.	*Americans.*			
Australians.			Negroes.	*Mincopies* (?)
			Negritos.	

** *The names of the stocks known only since the fifteenth century are put into italics. If the "Skrälings" of the Norse discoverers of America were Esquimaux, Europeans became acquainted with the latter six or seven centuries earlier.*

Under each of these divisions are two columns, one for the Brachycephali, or short heads, and one for the Dolichocephali,* or long heads. Again, each column is subdivided transversely into four compartments, one for the "leucous," people with fair complexions and yellow or red hair; one for the "leucomelanous," with dark hair and pale skins; one for the "xanthomelanous," with black hair and yellow, brown, or olive skins; and one for the "melanous," with black hair and dark brown or blackish skins.

It is curious to observe that almost all the woolly-haired people are also long-headed; while among the straight-haired nations broad heads preponderate, and only two stocks, the Esquimaux and the Australians, are exclusively long-headed.

* Skulls, the transverse diameter of which is more than eight-tenths the long diameter, are short; those which have the transverse diameter less than eight-tenths the longitudinal, are long.

One of the acutest and most original of ethnologists, Desmoulins, originated the idea, which has subsequently been fully developed by Agassiz, that the distribution of the persistent modifications of man is governed by the same laws as that of other animals, and that both fall into the same great distributional provinces. Thus, Australia, America, south of Mexico; the Arctic regions; Europe, Syria, Arabia, and North Africa, taken together, are each regions eminently characterised by the nature of their animal and vegetable populations, and each, as we have seen, has its peculiar and characteristic form of man. But it may be doubted whether the parallel thus drawn will hold good strictly, and in all cases. The Tasmanian Fauna and Flora are essentially Australian, and the like is true, to a less extent, of many, if not of all, the Papuan islands; but the Negritos who inhabit these islands are strikingly different from the Australians. Again, the differences between the Mongolians and the Xanthochroi are out of all proportion greater than those between the Faunæ and Floræ of Central and Eastern Asia. But whatever the difficulties in the way of the detailed application of this comparison of the distribution of men with that of animals, it is well worthy of being borne in mind, and carried as far as it will go.

Apart from all speculation, a very curious fact regarding the distribution of the persistent modifications of mankind becomes apparent on inspecting an Ethnological chart, projected in such a manner that the Pacific Ocean occupies its centre. Such a chart exhibits an Australian area occupied by dark smooth-haired people, separated by an incomplete inner zone of dark woolly-haired Negritos and Negroes, from an outer zone of comparatively pale and smooth-haired men, occupying the Americas, and nearly all Asia* and North Africa†

Such is a brief sketch of the characters and distribution of the persistent modifications, or stocks, of mankind at the present day. If we seek for direct evidence of how long this state of things has lasted, we shall find little enough, and that little far from satisfactory. Of the eleven different stocks enumerated, seven have been known to us for less than 400 years; and of these seven not one possessed a fragment of written history at the time it came into contact with European civilization. The other four — the Negroes, Mongolians, Xanthochroi, and Melanochroi — have always existed in some of the localities in which they are now found, nor do the negroes ever seem to have voluntarily travelled beyond the limits of their present area. But ancient history is in

[* Hindostan excepted.— 1894.]
[† Egypt excepted.— 1894.]

a great measure the record of the mutual encroachments of the other three stocks.

On the whole, however, it is wonderful how little change has been effected by these mutual invasions and intermixtures. As at the present time, so at the dawn of history, the Melanochroi fringed the Atlantic and the Mediterranean; the Xanthochroi occupied most of Central and Eastern Europe, and much of Western and Central Asia; while Mongolians held the extreme east of the Old World. So far as history teaches us, the populations of Europe, Asia, and Africa were, twenty* centuries ago, just what they are now, in their broad features and general distribution.

The evidence yielded by Archæology is not very definite, but so far as it goes, it is to much the same effect. The mound builders of Central America seem to have had the characteristic short and broad head of the modern inhabitants of that continent. The tumuli and tombs of Ancient Scandinavia, of pre-Roman Britain, of Gaul, of Switzerland, reveal two types of skull — a broad and a long — of which, in Scandinavia, the broad seems to have belonged to the older stock, while the reverse is probably the case in Britain, and certainly in Switzerland. It has been assumed that the broad-skulled people of ancient Scandinavia were Lapps; but there is no proof of the fact, and they may have been, like the broad-skulled Swiss and Germans, Xanthochroi. One of the greatest of ethnological difficulties is to know where the modern Swedes, Norsemen, and Saxons got their long heads, as all their neighbors, Fins, Lapps, Slavonians, and South Germans, are broad-headed. Again, who were the small-handed † long-headed people of the "bronze epoch," and what has become of the infusion of their blood among the Xanthochroi?

At present Palæontology yields no safe data to the ethnologist. We know absolutely nothing of the ethnological characters of the men of Abbeville and Hoxne; but must be content with the demonstration, in itself of immense value, that Man existed in Western Europe when its physical condition was widely different from what it is now, and when animals existed, which, though they belong to what is, properly speaking, the present order of things, have long been extinct. Beyond the limits of a fraction of Europe, Palæontology tells us nothing of man or of his works.

To sum up our knowledge of the ethnological past of man; so far as the light is bright, it shows him substantially as he is

[* We may now safely say thirty or forty.— 1894.]

[† Supposed to be small-handed from the small handles of their bronze swords. But I observe in the Assyrian sculptures the same small handles, while the hands are by no means small. How did the Assyrians use their swords? So far as I know thrusting alone is represented.— 1894.]

now; and, when it grows dim, it permits us to see no sign that he was other than he is now.

It is a general belief that men of different stocks differ as much physiologically as they do morphologically; but it is very hard to prove, in any particular case, how much of a supposed national characteristic is due to inherent physiological peculiarities, and how much to the influence of circumstances. There is much evidence to show, however, that some stocks enjoy a partial or complete immunity from diseases which destroy, or decimate, others. Thus there seems good ground for the belief that Negroes are remarkably exempt from yellow fever; and that, among Europeans, the melanochroic people are less obnoxious to its ravages than the xanthochroic. But many writers, not content with physiological differences of this kind, undertake to prove the existence of others of far greater moment; and, indeed, to show that certain stocks of mankind exhibit, more or less distinctly, the physiological characters of true species. Unions between these stocks, and still more between the half-breeds arising from the mixture, are affirmed to be either infertile, or less fertile than those which take place between males and females of either stock under the same circumstances. Some go so far as to assert that no mixed breeds of mankind can maintain themselves without the assistance of one or other of the parent stocks, and that, consequently, they must inevitably be obliterated in the long run.

Here, again, it is exceedingly difficult to obtain trustworthy evidence and to free the effects of the pure physiological experiment from adventitious influences. The only trial which, by a strange chance, was kept clear of all such influences — the only instance in which two distinct stocks of mankind were crossed, and their progeny intermarried without any admixture from without — is the famous case of the Pitcairn Islanders, who were the progeny of Bligh's English sailors by Tahitian women. The results of this experiment, as everybody knows, are dead against those who maintain the doctrine of human hybridity, seeing that the Pitcairn Islanders, even though they necessarily contracted consanguineous marriages, throve and multiplied exceedingly.

But those who are disposed to believe in this doctrine should study the evidence brought forward in its support by M. Broca, its latest and ablest advocate, and compare this evidence with that which the botanists, as represented by a Gaertner or by a Darwin, think it indispensable to obtain before they will admit the infertility of crosses between two allied kinds of plants. They will then, I think, be satisfied that the doctrine in question rests upon a very unsafe foundation; that the facts adduced in its sup-

port are capable of many other interpretations; and, indeed, that from the very nature of the case, demonstrative evidence one way or the other is almost unattainable. *A priori,* I should be disposed to expect a certain amount of infertility between some of the extreme modifications of mankind; and still more between the offsprings of their intermixture. *A posteriori,* I cannot discover any satisfactory proof that such infertility exists.

From the facts of ethnology I now turn to the theories and speculations of ethnologists, which have been devised to explain these facts, and to furnish satisfactory answers to the inquiry — what conditions have determined the existence of the persistent modifications of mankind, and have caused their distribution to be what it is?

These speculations may be grouped under three heads: firstly, the Monogenist hypotheses; secondly, those of the Polygenists; and thirdly, that which would result from a simple application of Darwinian principles to mankind.

According to the Monogenists, all mankind have sprung from a single pair, whose multitudinous progeny spread themselves over the world, such as it now is, and became modified into the forms we meet with in the various regions of the earth, by the effect of the climatal and other conditions to which they were subjected.

The advocates of this hypothesis are divisible into several schools. There are those who represent the most numerous, respectable, and would-be orthodox of the public, and are what may be called "Adamites," pure and simple. They believe that Adam was made out of earth somewhere in Asia, about six thousand years ago; that Eve was modelled from one of his ribs; and that the progeny of these two having been reduced to eight persons who were landed on the summit of Mount Ararat after an universal deluge, all the nations of the earth have proceeded from these last, have migrated to their present localities, and have become converted into Negroes, Australians, Mongolians, &c., within that time. Five-sixths of the public are taught this Adamitic Monogenism, as if it were an established truth, and believe it. I do not; and I am not acquainted with any man of science, or duly instructed person, who does.

A second school of monogenists, not worthy of much attention, attempts to hold a place midway between the Adamites and a third division, who take up a purely scientific position, and require to be dealt with accordingly. This third division, in fact, numbers in its ranks Linnæus, Buffon, Blumenbach, Cuvier, Prichard, and many distinguished living ethnologists.

These "Rational Monogenists," or, at any rate the more mod-

ern among them, hold, firstly, that the present condition of the earth has existed for untold ages; secondly, that, at a remote period, beyond the ken of Archbishop Usher, man was created, somewhere between the Caucasus and the Hindoo Koosh; thirdly, that he might have migrated thence to all parts of the inhabited world, seeing that none of them are unattainable from some other inhabited part, by men provided with only such means of transport as savages are known to possess and must have invented; fourthly, that the operation of the existing diversities of climate and other conditions upon people so migrating, is sufficient to account for all the diversities of mankind.

Of the truth of the first of these propositions no competent judge now entertains any doubt. The second is more open to discussion; for, in these latter days, many question the special creation of man: and even if his special creation be granted, there is not a shadow of a reason why he should have been created in Asia rather than anywhere else. Of all the odd myths that have arisen in the scientific world, the "Caucasion mystery," invented quite innocently by Blumenbach, is the oddest. A Georgian woman's skull was the handsomest in his collection. Hence it became his model exemplar of human skulls, from which all others might be regarded as deviations; and out of this, by some strange intellectual hocuspocus, grew up the notion that the Caucasian man is the prototype "Adamic" man, and his country the primitive centre of our kind. Perhaps the most curious thing of all is, that the said Georgian skull, after all, is not a skull of average form, but distinctly belongs to the brachycephalic group.

With the third proposition I am quite disposed to agree, though it must be recollected that it is one thing to allow that a given migration is possible, and another to admit there is good reason to believe it has really taken place.

But I can find no sufficient ground for accepting the fourth proposition; and I doubt if it would ever have obtained its general currency except for the circumstance that fair Europeans are very readily tanned and embrowned by the sun. Yet I am not aware that there is a particle of proof that the cutaneous change thus effected can become hereditary, any more than that the enlarged livers, which plague our countrymen of India, can be transmitted; while there is very strong evidence to the contrary. Not only, in fact, are there such cases as those of the English families in Barbadoes, who have remained for six generations unaltered in complexion, but which are open to the objection that they may have received infusions of fresh European blood; but there is the broad fact, that not a single indigenous Negro exists either in the

great alluvial plains of tropical South America, or in the exposed islands of the Polynesian Archipelago, or among the populations of equatorial Borneo or Sumatra. No satisfactory explanation of these obvious difficulties has been offered by the advocates of the direct influences of conditions. And as for the more important modifications observed in the structure of the brain, and in the form of the skull, no one has ever pretended to show in what way they can be effected directly by climate.

It is here, in fact, that the strength of the Polygenists, or those who maintain that men primitively arose, not from one, but from many stocks, lies. Show us, they say to the Monogenists, a single case in which the characters of a human stock have been essentially modified without its being demonstrable, or, at least, highly probable that there has been intermixture of blood with some foreign stock. Bring forward any instance in which a part of the world, formerly inhabited by one stock, is now the dwelling-place of another, and we will prove the change to be the result of migration, or of intermixture, and not of modification of character by climatic influences. Finally, prove to us that the evidence in favour of the specific distinctness of many animals, admitted to be distinct species by all zoologists, is a whit better than that upon which we maintain the specific distinctness of men.

If presenting unanswerable objections to your adversary were the same thing as proving your own case, the Polygenists would be in a fair way towards victory; but, unfortunately, as I have already observed, they have as yet completely failed to adduce satisfactory positive proof of the specific diversity of mankind. Like the Monogenists, the Polygenists are of several sects; some imagine that their assumed species of mankind were created where we find them — the African in Africa, and the Australian in Australia, along with the other animals of their distributional province; others conceive that each species of man has resulted from the modification of some antecedent species of ape — the American from the broad-nosed Simians of the New World, the African from the Troglodytic stock, the Mongolian from the Orangs.

The first hypothesis is hardly likely to win much favour. The whole tendency of modern science is to thrust the origination of things further and further into the background; and the chief philosophical objection to Adam being, not his oneness, but the hypothesis of his special creation; the multiplication of that objection tenfold is, whatever it may look, an increase, instead of a diminution, of the difficulties of the case. And, as to the second

alternative, it may safely be affirmed that, even if the differences between men are specific, they are so small, that the assumption of more than one primitive stock for all is altogether superfluous. Surely no one can now be found to assert that any two stocks of mankind differ as much as a chimpanzee and an orang do; still less that they are as unlike as either of these is to any New World Simian!

Lastly, the granting of the Polygenist premises does not, in the slightest degree, necessitate the Polygenist conclusion. Admit that Negroes and Australians, Negritos and Mongols are distinct species, or distinct genera, if you will, and you may yet, with perfect consistency, be the strictest of Monogenists, and even believe in Adam and Eve as the primæval parents of all mankind.

It is to Mr. Darwin we owe this discovery: it is he who, coming forward in the guise of an eclectic philosopher, presents his doctrine as the key to ethnology, and as reconciling and combining all that is good in the Monogenistic and Polygenistic schools. It is true that Mr. Darwin has not, in so many words, applied his views to ethnology; but even he who "runs and reads" the "Origin of Species" can hardly fail to do so; and, furthermore, Mr. Wallace and M. Pouchet have recently treated of ethnological questions from this point of view. Let me, in conclusion, add my own contribution to the same store.

I assume Man to have arisen in the manner which I have discussed elsewhere, and probably, though by no means necessarily, in one locality. Whether he arose singly, or a number of examples appeared contemporaneously, is also an open question for the believer in the production of species by the gradual modification of pre-existing ones. At what epoch of the world's history this took place, again, we have no evidence whatever. It may have been in the older tertiary, or earlier; but what is most important to remember is, that the discoveries of late years have proved that man inhabited Western Europe, at any rate, before the occurrence of those great physical changes which have given Europe its present aspect. And as the same evidence shows that man was the contemporary of animals which are now extinct, it is not too much to assume that his existence dates back at least as far as that of our present Fauna and Flora, or before the epoch of the drift.

But if this be true, it is somewhat startling to reflect upon the prodigious changes which have taken place in the physical geography of this planet since man has been an occupant of it.

During that period the greater part of the British islands, of Central Europe, of Northern Asia, have been submerged beneath

the sea and raised up again. So has the great desert of Sahara, which occupies the major part of Northern Africa.* The Caspian and the Aral seas have been one, and their united waters have probably communicated with both the Arctic and the Mediterranean oceans.† The greater part of North America has been under water, and has emerged. It is highly probable that a large part of the Malayan Archipelago has sunk, and that its primitive continuity with Asia has been destroyed. Over the great Polynesian area subsidence has taken place to the extent of many thousands of feet — subsidence of so vast a character, in fact, that if a continent like Asia had once occupied the area of the Pacific, the peaks of its mountains would now show not more numerous than the islands of the Polynesian Archipelago.‡

What lands may have been thickly populated for untold ages, and subsequently have disappeared and left no sign above the waters, it is of course impossible for us to say; but unless we are to make the wholly unjustifiable assumption that no dry land arose elsewhere when our present dry land sank, there must be half-a-dozen Atlantises beneath the waves of the various oceans of the world. But if the regions which have undergone these slow and gradual, but immense alterations, were wholly or in part inhabited before the changes I have indicated began — and it is more probable that they were than that they were not — what a wonderfully efficient "Emigration Board" must have been at work all over the world long before canoes, or even rafts, were invented; and before men were impelled to wander by any desire nobler or stronger than hunger. And as these rude and primitive families were thrust, in the course of long series of generations, from land to land, impelled by encroachments of sea or marsh, or by severity of summer heat or winter cold, to change their positions, what opportunities must have been offered for the play of natural selection, in preserving one family variation and destroying another!

Suppose, for example, that some families of a horde which had reached a land charged with the seeds of yellow fever, varied in the direction of woolliness of hair and darkness of skin. Then, if it be true that these physical characters are accompanied by comparative or absolute exemptions from that scourge, the inevitable tendency would be to the preservation and multiplica-

[* Later investigations tend to show that only a small part of the Sahara has been submerged.— 1894.]

[† With reference to certain reclamations that have been made *à propos* of a speculation set forth in an essay on the *Aryan Question* (*infrà*), I draw attention to the fact that this passage was written twenty-nine years ago.— 1894.]

[‡ The occurrence of this extensive subsidence is disputed.— 1894.]

tion of the darker and woollier families, and the elimination of the whiter and smoother haired. In fact, by the operation of causes precisely similar to those which, in the famous instance cited by Mr. Darwin, have given rise to a race of black pigs in the forests of Louisiana, a negro stock would eventually people the region.* Again, how often, by such physical changes, must a stock have been isolated from all others for innumerable generations, and have found ample time for the hereditary hardening of its special peculiarities into the enduring characters of a persistent modification.

Nor, if it be true that the physiological differences of species may be produced by variation and natural selection, as Mr. Darwin supposes, would it be at all astonishing, if, in some of these separated stocks, the process of differentiation should have gone so far as to give rise to the phenomena of hybridity. In the face of the overwhelming evidence in favour of the unity of the origin of mankind afforded by anatomical considerations, satisfactory proof of the existence of any degree of sterility in the unions of members of two of the "persistent modifications" of mankind, might well be appealed to by Mr. Darwin as crucial evidence of the truth of his views regarding the origin of species in general.

[* Mr. Pearson, in his very interesting work *On National Life and Character*, justly dwells upon the obstacles to the existence of the white races within the Tropics. There is, however, this point to be considered, that the fevers to which the white men succumb are probably caused by microbes; and that modern therapeutic science is daily teaching us more and more about the ways of obtaining immunity from or alleviating these attacks. What would become of black competition if fever "vaccination" proved effectual?— 1894.]

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V.

ON SOME FIXED POINTS IN BRITISH ETHNOLOGY.

IN view of the many discussions to which the complicated problems offered by the ethnology of the British Islands have given rise, it may be useful to attempt to pick out, from amidst the confused masses of assertion and of inference, those propositions which appear to rest upon a secure foundation, and to state the evidence by which they are supported. Such is the purpose of the present paper.

Some of these well-based propositions relate to the physical characters of the people of Britain and their neighbours; while others concern the languages which they spoke. I shall deal, in the first place, with the physical questions.

I. *Eighteen hundred years ago the population of Britain comprised people of two types of complexion — the one fair, and the other dark. The dark people resembled the Aquitani and the Iberians; the fair people were like the Belgic Gauls.*

The chief direct evidence of the truth of this proposition is the well-known passage of Tacitus:—

"Ceterum Britanniam qui mortales initio coluerint, indigenæ an advecti, ut inter barbaros, parum compertum. Habitus corporum varii: atque ex eo argumenta: namque rutilæ Caledoniam habitantium comæ, magni artus, Germanicam originem asseverant. Silurum colorati vultus et torti plerumque crines, et posita contra Hispania, Iberos veteres trajecisse, easque sedes occupasse, fidem faciunt. Proximi Gallis et similes sunt; seu durante originis vi, seu procurrentibus in diversa terris, positio cœli corporibus habitum dedit. In universum tamen æstimanti, Gallos vicinum solum occupasse, credibile est; eorum sacra deprehendas, superstitionum persuasione; sermo haud multum diversus." *

This passage, it will be observed, contains statements as to facts, and certain conclusions deduced from these facts. The matters of fact asserted are: firstly, that the inhabitants of Britain exhibit much diversity in their physical characters; secondly, that the Caledonians are red-haired and large-limbed, like the Ger-

* Tacitus *Agricola*, c. 11.

mans; thirdly, that the Silures have curly hair and dark complexions, like the people of Spain; fourthly, that the British people nearest Gaul resemble the "Galli."

Tacitus, therefore, states positively what the Caledonians and Silures were like; but the interpretation of what he says about the other Britons must depend upon what we learn from other sources as to the characters of these "Galli." Here the testimony of "divus Julius" comes in with great force and appropriateness. Cæsar writes:—

"Britanniæ pars interior ab iis incolitur, quos natos in insula ipsi memoria proditum dicunt: marituma pars ab iis, qui prædæ ac belli inferendi causa ex Belgio transierant; qui omnes fere iis nominibus civitatum appellantur quibus orti ex civitatibus eo pervenerunt, et bello inlato ibi permanserunt atque agros colere cœperunt." *

From these passages it is obvious that, in the opinion of Cæsar and Tacitus, the southern Britons resembled the northern Gauls, and especially the Belgæ; and the evidence of Strabo is decisive as to the characters in which the two people resembled one another: "The men [of Britain] are taller than the Kelts, with hair less yellow; they are slighter in their persons."†

The evidence adduced appears to leave no reasonable ground for doubting that, at the time of the Roman conquest, Britain contained people of two types, the one dark and the other fair complexioned, and that there was a certain difference between the latter in the north and in the south of Britain: the northern folk being, in the judgment of Tacitus, or, more properly, according to the information he had received from Agricola and others, more similar to the Germans than the latter. As to the distribution of these stocks, all that is clear is, that the dark people were predominant in certain parts of the west of the southern half of Britain, while the fair stock appears to have furnished the chief elements of the population elsewhere.

No ancient writer troubled himself with measuring skulls, and therefore there is no direct evidence as to the cranial characters of the fair and the dark stocks. The indirect evidence is not very satisfactory. The tumuli of Britain of pre-Roman date have yielded two extremely different forms of skull, the one broad and the other long; and the same variety has been observed in the skulls of the ancient Gauls.‡ The suggestion is obvious that the one form of skull may have been associated with the fair, and the

* *De Bello Gallico*, v. 12.

† The Geography of Strabo. Translated by Hamilton and Falconer, v. 5.

‡ See Dr. Thurman "On the Two Principal Forms of Ancient British and Gaulish Skulls."

other with the dark, complexion. But any conclusion of this kind is at once checked by the reflection that the extremes of long and short-headedness are to be met with among the fair inhabitants of Germany and of Scandinavia at the present day — the south-western Germans and the Swiss being markedly broad-headed, while the Scandinavians are as predominantly long-headed.

What the natives of Ireland were like at the time of the Roman conquest of Britain, and for centuries afterwards, we have no certain knowledge; but the earliest trustworthy records prove the existence, side by side with one another, of a fair and a dark stock, in Ireland as in Britain. The long form of skull is predominant among the ancient, as among modern, Irish.

II. *The people termed Gauls, and those called Germans, by the Romans, did not differ in any important physical character.*

The terms in which the ancient writers describe both Gauls and Germans are identical. They are always tall people, with massive limbs, fair skins, fierce blue eyes, and hair the colour of which ranges from red to yellow. Zeuss, the great authority on these matters, affirms broadly that no distinction in bodily feature is to be found between the Gauls, the Germans, and the Wends, so far as their characters are recorded by the old historians; and he proves his case by citations from a cloud of witnesses.

An attempt has been made to show that the colour of the hair of the Gauls must have differed very much from that which obtained among the Germans, on the strength of the story told by Suetonius (*Caligula*, 4), that Caligula tried to pass off Gauls for Germans by picking out the tallest, and making then "rutilare et summittere comam."

The Baron de Belloguet remarks upon this passage:

> "It was in the very north of Gaul, and near the sea, that Caligula got up this military comedy. And the fact proves that the Belgæ were already sensibly different from their ancestors, whom Strabo had found almost identical with their *brothers* on the other side of the Rhine."

But the fact recorded by Suetonius, if fact it be, proves nothing; for the Germans themselves were in the habit of reddening their hair. Ammianus Marcellinus* tells how, in the year 367 A. D., the Roman commander, Jovinus, surprised a body of Alemanni near the town now called Charpeigne, in the valley of the Moselle; and how the Roman soldiers, as, concealed by the thick wood, they stole upon their unsuspecting enemies, saw that some were bathing and others "comas rutilantes ex more." More than

* *Res Gestæ*, xxvii.

two centuries earlier Pliny gives indirect evidence to the same effect when he says of soap:—

"Galliarum hoc inventum rutilandis capillis . . . apud Germanos majore in usu viris quam fœminis."*

Here we have a writer who flourished not very long after the date of the Caligula story, telling us that the Gauls invented soap for the purpose of doing that which, according to Suetonius, Caligula forced them to do. And, further, the combined and independent testimony of Pliny and Ammianus assures us that the Germans were as much in the habit of reddening their hair as the Gauls. As to De Belloguet's supposition that, even in Caligula's time, the Gauls had become darker than their ancestors were, it is directly contradicted by Ammianus Marcellinus, who knew the Gauls well. "Celsioris staturæ et candidi pœne Galli sunt omnes, et rutili, luminumque torvitate terribiles," is his description; and it would fit the Gauls who sacked Rome.

III. *In none of the invasions of Britain which have taken place since the Roman dominion, has any other type of man been introduced than one or other of the two which existed during that dominion.*

The North Germans, who effected what is commonly called the Saxon conquest of Britain, were, most assuredly, a fair, yellow, or red-haired, blue-eyed, long-skulled people. So were the Danes and the Norsemen who followed them; though it is very possible that the active slave trade which went on, and the intercourse with Ireland, may have introduced a certain admixture of the dark stock into both Denmark and Norway. The Norman conquest brought in new ethnological elements, the precise value of which cannot be estimated with exactness; but as to their quality, there can be no question, inasmuch as even the wide area from which William drew his followers could yield him nothing but the fair and the dark types of men, already present in Britain. But whether the Norman settlers, on the whole, strengthened the fair or the dark element, is a problem, the elements of the solution of which are not attainable.

I am unable to discover any grounds for believing that a Lapp element has ever entered into the population of these islands. So far as the physical evidence goes, it is perfectly consistent with the hypothesis that the only constituent stock of that population, now, or at any other period about which we have evidence, are the dark whites, whom I have proposed to call "*Melanochroi*," and the fair whites, or "*Xanthochroi*."

* *Historia Naturalis*, xxviii. 51.

IV. *The Xanthochroi and the Melanochroi of Britain are, speaking broadly, distributed, at present, as they were in the time of Tacitus; and their representatives on the continent of Europe have the same general distribution as at the earliest period of which we have any record.*

At the present day, and notwithstanding the extensive intermixture effected by the movements consequent on civilization and on political changes, there is a predominance of dark men in the west, and of fair men in the east and north, of Britain. At the present day, as from the earliest times, the predominant constituents of the riverain population of the North Sea and the eastern half of the British Channel, are fair men. The fair stock continues in force through Central Europe, until it is lost in Central Asia. Offshoots of this stock extend into Spain, Italy, and Northern India, and by way of Syria and North Africa, to the Canary Islands. They were known in very early times to the Chinese, and in still earlier to the ancient Egyptians, as frontier tribes. The Thracians were notorious for their fair hair and blue eyes many centuries before our era.

On the other hand, the dark stock predominates in Southern and Western France, in Spain, along the Ligurian shore, and in Western and Southern Italy; in Greece, Asia, Syria, and North Africa; in Arabia, Persia, Afghanistan, and Hindostan, shading gradually, through all stages of darkening, into the type of the modern Egyptian, or of the wild Hill-man of the Dekkan. Nor is there any record of the existence of a different population in all these countries.

The extreme north of Europe, and the northern part of Western Asia, are at present occupied by a Mongoloid stock, and, in the absence of evidence to the contrary, may be assumed to have been so peopled from a very remote epoch. But, as I have said, I can find no evidence that this stock ever took part in peopling Britain. Of the three great stocks of mankind which extend from the western coast of the great Eurasiatic continent to its southern and eastern shores, the Mongoloids occupy a vast triangle, the base of which is the whole of Eastern Asia, while its apex lies in Lapland. The Melanochroi, on the other hand, may be represented as a broad band stretching from Ireland to Hindostan; while the Xanthochroic area lies between the two, thins out, so to speak, at either end, and mingles, at its margins, with both its neighbours.

Such is a brief and summary statement of what I believe to be the chief facts relating to the physical ethnology of the people of Britain. The conclusions which I draw from these and other facts are — (1) That the Melanochroi and the Xanthochroi are

two separate races in the biological sense of the word race; (2) That they have had the same general distribution as at present from the earliest times of which any record exists on the continent of Europe; (3) That the population of the British Islands is derived from them, and from them only.

The people of Europe, however, owe their national names, not to their physical characteristics, but to their languages, or to their political relations; which, it is plain, need not have the slightest relation to these characteristics.

Thus, it is quite certain that, in Cæsar's time, Gaul was divided politically into three nationalities — the Belgæ, the Celtæ, and the Aquitani; and that the last were very widely different, both in language and in physical characteristics, from the two former. The Belgæ and the Celtæ, on the other hand, differed comparatively little either in physique or in language. On the former point there is the distinct testimony of Strabo; as to the latter, St. Jerome states that the "Galatians had almost the same language as the Treviri." Now, the Galatians were emigrant Volcæ Tectosages, and therefore, Celtæ; while the Treviri were Belgæ.*

At the present day, the physical characters of the people of Belgic Gaul remain distinct from those of the people of Aquitaine, notwithstanding the immense changes which have taken place since Cæsar's time; but Belgæ, Celtæ, and Aquitani (all but a mere fraction of the last two, represented by the Basques and the Bretons) are fused into one nationality, "le peuple Français." But they have adopted the language of one set of invaders, and the name of another; their original names and languages have almost disappeared. Suppose that the French language remained as the sole evidence of the existence of the population of Gaul, would the keenest philologer arrive at any other conclusion than that this population was essentially and fundamentally a "Latin" race, which had had some communication with Celts and Teutons? Would he so much as suspect the former existence of the Aquitani?

Community of language testifies to close contact between the people who speak the language, but to nothing else; philology has absolutely nothing to do with ethnology, except so far as it suggests the existence or the absence of such contact. The contrary assumption, that language is a test of race, has introduced the utmost confusion into ethnological speculation, and has nowhere worked greater scientific and practical mischief than in the ethnology of the British Islands.

What is known, for certain, about the languages spoken in these islands and their affinities may, I believe, be summed up as follows:—

[* This proposition is disputed.— 1894.]

I. *At the time of the Roman conquest, one language, the Celtic, under two principal dialectical divisions, the Cymric and the Gaelic, was spoken throughout the British Islands. Cymric was spoken in Britain, Gaelic* in Ireland.*

If a language allied to Basque had in earlier times been spoken in the British Islands, there is no evidence that any Euskarian-speaking people remained at the time of the Roman conquest. The dark and the fair population of Britain alike spoke Celtic tongues, and therefore the name "Celt" is as applicable to the one as to the other.

What was spoken in Ireland can only be surmised by reasoning from the knowledge of later times; but there seems to be no doubt that it was Gaelic.

II. *The Belgæ and the Celtæ, with the offshoots of the latter in Asia Minor, spoke dialects of the Cymric division of Celtic.*

The evidence of this proposition lies in the statement of St. Jerome before cited; in the similarity of the names of places in Belgic Gaul and in Britain; and in the direct comparison of sundry ancient Gaulish and Belgic words which have been preserved, with the existing Cymric dialects, for which I must refer to the learned work of Brandes.

Formerly, as at the present day, the Cymric dialects of Celtic were spoken by both the fair and the dark stocks.

III. *There is no record of Gaelic being spoken anywhere save in Ireland, Scotland, and the Isle of Man.*

This appears to be the final result of the long discussions which have taken place on this much-debated question. As is the case with the Cymric dialects, Gaelic is now spoken by both dark and fair stocks.

IV. *When the Teutonic languages first became known, they were spoken only† by Xanthochroi, that is to say, by the Germans, the Scandinavians, and Goths. And they were imported by Xanthochroi into Gaul and into Britain.*

In Gaul, the imported Teutonic dialect has been completely overpowered by the more or less modified Latin, which it found already in possession; and what Teutonic blood there may be in modern Frenchmen is not adequately represented in their language. In Britain, on the contrary, the Teutonic dialects have overpowered the pre-existing forms of speech, and the people are

[* I have been told that the terms "Cymric" and "Gaelic" are antiquated and improper. The reader will please substitute Celtic dialect A and Celtic dialect B for them, and consult, on this subject, especially with regard to proposition III., Professor Rhys' *Early Britain*.— 1894.]

[† "Only" is too strong a word, as there were doubtless some Melanochroi among the Teutonic tribes.— 1894.]

vastly less "Teutonic" than their language. Whatever may have been the extent to which the Celtic-speaking population of the eastern half of Britain was trodden out and supplanted by the Teutonic-speaking Saxons and Danes, it is quite certain that no considerable displacement of the Celtic-speaking people occurred in Cornwall, Wales, or the Highlands of Scotland; and that nothing approaching to the extinction of that people took place in Devonshire, Somerset, or the western moiety of Britain generally. Nevertheless, the fundamentally Teutonic English language is now spoken throughout Britain, except by an insignificant fraction of the population in Wales and the Western Highlands. But it is obvious that this fact affords not the slightest justification for the common practice of speaking of the present inhabitants of Britain as an "Anglo-Saxon" race. It is, in fact, just as absurd as the habit of talking of the French people as a "Latin" race, because they speak a language which is, in the main, derived from Latin. And the absurdity becomes the more patent when those who have no hesitation in calling a Devonshire man, or a Cornish man, an "Anglo-Saxon," would think it ridiculous to call a Tipperary man by the same title, though he and his forefathers may have spoken English for as long a time as the Cornish man.

Ireland, at the earliest period of which we have any knowledge, contained, like Britain, a dark and fair stock, which there is every reason to believe, were identical with the dark and the fair stocks of Britain. When the Irish first became known they spoke a Gaelic dialect, and though, for many centuries, Scandinavians made continual incursions upon, and settlements among them, the Teutonic languages made no more way among the Irish than they did among the French. How much Scandinavian blood was introduced there is no evidence to show. But after the conquest of Ireland by Henry II., the English people, consisting in part of the descendants of Cymric speakers, and in part of the descendants of Teutonic speakers, made good their footing in the eastern half of the island, as the Saxons and Danes made good theirs in England; and did their best to complete the parallel by attempting the extirpation of the Gaelic-speaking Irish. And they succeeded to a considerable extent; a large part of Eastern Ireland is now peopled by men who are substantially English by descent, and the English language has spread over the land far beyond the limits of English blood.

Ethnologically, the Irish people were originally, like the people of Britain, a mixture of Melanochroi and Xanthochroi. They resembled the Britons in speaking a Celtic tongue; but it was a Gaelic and not a Cymric form of the Celtic language. Ireland

was untouched by the Roman conquest, nor do the Saxons seem to have had any influence upon her destinies, but the Danes and Norsemen poured in a contingent of Teutonism, which has been largely supplemented by English and Scotch efforts.

What, then, is the value of the ethnological difference between the Englishman of the western half of England and the Irishman of the eastern half of Ireland? For what reason does the one deserve the name of a "Celt," and not the other? And further, if we turn to the inhabitants of the western half of Ireland, why should the term "Celts" be applied to them more than to the inhabitants of Cornwall? And if the name is applicable to one as justly as to the other, why should not intelligence, perseverance, thrift, industry, sobriety, respect for law, be admitted to be Celtic virtues? And why should we not seek for the cause of their absence in something else than the idle pretext of "Celtic blood"?

I have been unable to meet with any answers to these questions.

V. *The Celtic and the Teutonic dialects are members of the same great Aryan family of languages; but there is evidence to show that a non-Aryan language was at one time spoken over a large extent of the area occupied by Melanochroi in Europe.*

The non-Aryan language here referred to is the Euskarian, now spoken only by the Basques, but which seems in earlier times to have been the language of the Aquitanians and Spaniards, and may possibly have extended much further to the East. Whether it has any connection with the Ligurian and Oscan dialects are questions upon which, of course, I do not presume to offer any opinion. But it is important to remark that it is a language the area of which has gradually diminished without any corresponding extirpation of the people who primitively spoke it; so that the people of Spain and of Aquitaine at the present day must be largely "Euskarian" by descent in just the same sense as the Cornish men are "Celtic" by descent.

Such seem to me to be the main facts respecting the ethnology of the British Islands and of Western Europe, which may be said to be fairly established. The hypothesis by which I think (with De Belloguet and Thurman) the facts may best be explained is this: In very remote times Western Europe and the British islands were inhabited by the dark stock, or the Melanochroi, alone, and these Melanochroi spoke dialects allied to the Euskarian. The Xanthochroi, spreading over the great Eurasiatic plains westward, and speaking Aryan dialects, gradually invaded the territories of the Melanochroi. The Xanthochroi, who thus came into contact with the Western Melanochroi, spoke a Celtic language, and that Celtic language, whether Cymric or Gaelic, spread

over the Melanochroi far beyond the limits of intermixture of blood, supplanting Euskarian, just as English and French have supplanted Celtic. Even as early as Cæsar's time, I suppose that the Euskarian was everywhere, except in Spain and in Aquitaine, replaced by Celtic, and thus the Celtic speakers were no longer of one ethnological stock, but of two. Both in Western Europe and in England a third wave of language — in the one case Latin, in the other Teutonic — has spread over the same area. In Western Europe, it has left a fragment of the primary Euskarian in one corner of the country, and a fragment of the secondary Celtic in another. In the British islands, only outlying pools of the secondary linguistic wave remain in Wales, the Highlands, Ireland, and the Isle of Man. If this hypothesis is a sound one, it follows that the name of Celtic is not properly applicable to the Melanochroic or dark stock of Europe. They are merely, so to speak, secondary Celts. The primary and aboriginal Celtic-speaking people are Xanthochroi — the typical Gauls of the ancient writers, and the close allies by blood, customs, and language, of the Germans.

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VI.

THE ARYAN QUESTION AND PREHISTORIC MAN.

THE rapid increase of natural knowledge, which is the chief characteristic of our age, is effected in various ways. The main army of science moves to the conquest of new worlds slowly and surely, nor ever cedes an inch of the territory gained. But the advance is covered and facilitated by the ceaseless activity of clouds of light troops provided with a weapon — always efficient, if not always an arm of precision — the scientific imagination. It is the business of these *enfants perdus* of science to make raids into the realm of ignorance wherever they see, or think they see, a chance; and cheerfully to accept defeat, or it may be annihilation, as the reward of error. Unfortunately, the public, which watches the progress of the campaign, too often mistakes a dashing incursion of the Uhlans for a forward movement of the main body; fondly imagining that the strategic movement to the rear, which occasionally follows, indicates a battle lost by science. And it must be confessed that the error is too often justified by the effects of the irrepressible tendency which men of science share with all other sorts of men known to me, to be impatient of that most wholesome state of mind — suspended judgment; to assume the objective truth of speculations which, from the nature of the evidence in their favour, can have no claim to be more than working hypotheses.

The history of the "Aryan question" affords a striking illustration of these general remarks.

About a century ago, Sir William Jones pointed out the close alliance of the chief European languages with Sanskrit and its derivative dialects now spoken in India. Brilliant and laborious philologists, in long succession, enlarged and strengthened this position, until the truth that Sanskrit, Zend, Armenian, Greek, Latin, Lithuanian, Slavonian, German, Celtic, and so on, stand to one another in the relation of descendants from a common stock, became firmly established, and thenceforward formed part of the permanent acquisitions of science. Moreover, the term "Aryan"

is very generally, if not universally, accepted as a name for the group of languages thus allied. Hence, when one speaks of "Aryan languages," no hypothetical assumptions are involved. It is a matter of fact that such languages exist, that they present certain substantial and formal relations, and that convention sanctions the name applied to them. But the close connection of these widely differentiated languages remains altogether inexplicable, unless it is admitted that they are modifications of an original relatively undifferentiated tongue; just as the intimate affinities of the Romance languages — French, Italian, Spanish, and the rest — would be incomprehensible if there were no Latin. The original or "primitive Aryan" tongue, thus postulated, unfortunately no longer exists. It is a hypothetical entity, which corresponds with the "primitive stock" of generic and higher groups among plants and animals; and the acknowledgment of its former existence, and of the process of evolution which has brought about the present state of things philological, is forced upon us by deductive reasoning of similar cogency to that employed about things biological.

Thus, the former existence of a body of relatively uniform dialects, which may be called primitive Aryan, may be added to the stock of definitely acquired truths. But it is obvious that, in the absence of writing or of phonographs, the existence of a language implies that of speakers. If there were primitive Aryan dialects, there must have been primitive Aryan people who used them; and those people must have resided somewhere or other on the earth's surface. Hence philology, without stepping beyond its legitimate bounds and keeping speculation within the limits of bare necessity, arrives not only at the conceptions of Aryan languages and of a primitive Aryan language; but of a primitive Aryan people and of a primitive Aryan home, or country occupied by them.

But where was this home of the Aryans? When the labours of modern philologists began, Sanskrit was the most archaic of all the Aryan languages known to them. It appeared to present the qualifications required in the parental or primitive Aryan. Brilliant Uhlans made a charge at this opening. The scientific imagination seated the primitive Aryans in the valley of the Ganges; and showed, as in a vision, the successive columns, guided by enterprising Brahmins, which set out thence to people the regions of the western world with Greeks and Celts and Germans. But the progress of philology itself sufficed to show that this Balaclava charge, however magnificent, was not profitable warfare. The internal evidence of the Vedas proved that their

composers had not reached the Ganges. On the other hand, the comparison of Zend with Sanskrit left no alternative open to the assumption that these languages were modifications of an original Indo-Iranian tongue, spoken by a people of whom the Aryans of India and those of Persia were offshoots, and who could therefore be hardly lodged elsewhere than on the frontiers of both Persia and India — that is to say, somewhere in the region which is at present known under the names of Turkestan, Afghanistan, and Kafiristan. Thus far, it can hardly be doubted that we are well within the ground of which science has taken enduring possession. But the Uhlans were not content to remain within the lines of this surely-won position. For some reason, which is not quite clear to me, they thought fit to restrict the home of the primitive Aryans to a particular part of the region in question; to lodge them amidst the bleak heights of the long range of the Hindoo Koosh and on the inhospitable plateau of Pamir. From their hives in these secluded valleys and wind-swept wastes, successive swarms of Celts and Greco-Latins, Teutons, and Slavs, were thrown off to settle, after long wanderings, in distant Europe. The Hindoo-Koosh-Pamir theory, once enunciated, gradually hardened into a sort of dogma; and there have not been wanting theorists, who laid down the routes of the successive bands of emigrants with as much confidence as if they had access to the records of the office of a primitive Aryan Quartermaster-General. It is really singular to observe the deference which has been shown, and is yet sometimes shown, to a speculation which can, at best, claim to be regarded as nothing better than a somewhat risky working hypothesis.

Forty years ago the credit of the Hindoo-Koosh-Pamir theory had risen almost to that of an axiom. The first person to instill doubt of its value into my mind was the late Robert Gordon Latham, a man of great learning and singular originality, whose attacks upon the Hindoo-Kooshite doctrine could scarcely have failed as completely as they did, if his great powers had been bestowed upon making his books not only worthy of being read, but readable. The impression left upon my mind, at that time, by various conversations about the "Sarmatian hypothesis," which my friend wished to substitute for the Hindoo-Koosh-Pamir speculation, was that the one and the other rested pretty much upon a like foundation of guess-work. That there was no sufficient reason for planting the primitive Aryans in the Hindoo Koosh, or in Pamir, seemed plain enough; but that there was little better ground, on the evidence then adduced, for settling them in the region at present occupied by Western Russia, or Podolia, ap-

peared to me to be not less plain. The most I thought Latham proved was, that the Aryan people of Indo-Iranian speech were just as likely to have come from Europe, as the Aryan people of Greek, or Teutonic, or Celtic speech from Asia. Of late years, Latham's views, so long neglected, or mentioned merely as an example of insular eccentricity, have been taken up and advocated with much ability in Germany as well as in this country — principally by philologists. Indeed, the glory of Hindoo-Koosh-Pamir seems altogether to have departed. Professor Max Müller, to whom Aryan philology owes so much, will not say more now, than that he holds by the conviction that the seat of the primitive Aryans was "somewhere in Asia." Dr. Schrader sums up in favor of European Russia; while Herr Penka would have us transplant the home of the primitive Aryans from Pamir in the far east to the Scandinavian peninsula in the far west.

I must refer those who desire to acquaint themselves with the philological arguments on which these conclusions are based to the recently published works of Dr. Schrader and Canon Taylor;* and to Penka's "Die Herkunft der Arier," which, in spite of the strong spice of the Uhlan which runs through it, I have found extremely well worth study. I do not pretend to be able to look at the Aryan question under any but the biological aspect; to which I now turn.

Any biologist who studies the history of the Aryan question, and, taking the philological facts on trust, regards it exclusively from the point of view of anthropology, will observe that, very early, the purely biological conception of "race" illegitimately mixed itself up with the ideas derived from pure philology. It is quite proper to speak of Aryan "people," because, as we have seen, the existence of the language implies that of a people who speak it; it might be equally permissible to call Latin people all those who speak Romance dialects. But, just as the application of the term Latin "race" to the divers people who speak Romance languages, at the present day, is none the less absurd because it is common; so, it is quite possible, that it may be equally wrong to call the people who spoke the primitive Aryan dialects and inhabited the primitive home, the Aryan race. "Aryan" is properly a term of classification used in philology. "Race" is the name of the sub-division of one of those groups of living things which are called "species" in the technical language of Zoology and Botany; and the term connotes the possession of characters distinct from

* Schrader, *Prehistoric Antiquities of the Aryan Peoples.* Translated by F. B. Jevons, M.A., 1890. Taylor, *The Origin of the Aryans,* 1890.

those of the other members of the species, which have a strong tendency to appear in the progeny of all members of the races. Such race-characters may be either bodily or mental, though in practice, the latter, as less easy of observation and definition, can rarely be taken into account. Language is rooted half in the bodily and half in the mental nature of man. The vocal sounds which form the raw materials of language could not be produced without a peculiar conformation of the organs of speech; the enunciation of duly accented syllables would be impossible without the nicest co-ordination of the action of the muscles which move these organs; and such co-ordination depends on the mechanism of certain portions of the nervous system. It is therefore conceivable that the structure of this highly complex speaking apparatus should determine a man's linguistic potentiality; that is to say, should enable him to use a language of one class and not of another. It is further conceivable that a particular linguistic potentiality should be inherited and become as good a race mark as any other. As a matter of fact, it is not proven that the linguistic potentialities of all men are the same. It is affirmed, for example, that, in the United States, the enunciation and the timbre of the voice of an American-born negro, however thoroughly he may have learned English, can be readily distinguished from that of a white man. But, even admitting that differences may obtain among the various races of men, to this extent, I do not think that there is any good ground for the supposition that an infant of any race would be unable to learn, and to use with ease, the language of any other race of men among whom it might be brought up. History abundantly proves the transmission of languages from some races to others; and there is no evidence, that I know of, to show that any race is incapable of substituting a foreign idiom for its native tongue.

From these considerations it follows that community of language is no proof of unity of race, is not even presumptive evidence of racial identity.* All that it does prove is that, at some time or other, free and prolonged intercourse has taken place be-

* Canon Taylor (*Origin of the Aryans*, p. 31) states that "Cuno . . . was the first to insist on what is now looked on as an axiom in ethnology — that race is not co-extensive with language," in a work published in 1871. I may be permitted to quote a passage from a lecture delivered on the 9th of January, 1870, which brought me into a great deal of trouble. "Physical, mental, and moral peculiarities go with blood and not with language. In the United States the negroes have spoken English for generations; but no one on that ground would call them Englishmen, or expect them to differ physically, mentally, or morally from other negroes."— *Pall Mall Gazette*, Jan. 10, 1870. But the "axiom in ethnology" had been implied, if not enunciated, before my time; for example, by Desmoulins in 1826.

tween the speakers of the same language. Philology, therefore, while it may have a perfect right to postulate the existence of a primitive Aryan "people," has no business to substitute "race" for "people." The speakers of primitive Aryan may have been a mixture of two or more races, just as are the speakers of English and of French, at the present time.

The older philological ethnologists felt the difficulty which arose out of their identification of linguistic with racial affinity, but were not dismayed by it. Strong in the prestige of their great discovery of the unity of the Aryan tongues, they were quite prepared to make the philological and the biological categories fit, by the exercise of a little pressure on that about which they knew less. And their judgment was often unconsciously warped by strong monogenistic proclivities, which, at bottom, however respectable and philanthropic their origin, had nothing to do with science. So the patent fact that men of Aryan speech presented widely diverse racial characters was explained away by maintaining that the physical differentiation was post-Aryan; to put it broadly, that the Aryans in Hindoo-Koosh-Pamir were truly of one race; but that, while one colony, subjected to the sweltering heat of the Gangetic plains, had fined down and darkened into the Bengalee, another had bleached and shot up, under the cool and misty skies of the north, into the semblance of Pomeranian Grenadiers; or of blue-eyed, fair-skinned, six-foot Scotch Highlanders. I do not know that any of the Uhlans who fought so vigorously under this flag are left now. I doubt if any one is prepared to say that he believes that the influence of external conditions, alone, accounts for the wide physical differences between Englishmen and Bengalese. So far as India is concerned, the internal evidence of the old literature sufficiently proves that the Aryan invaders were "white" men. It is hardly to be doubted that they intermixed with the dark Dravidian aborigines; and that the high-caste Hindoos are what they are in virtue of the Aryan blood which they have inherited,* and of the selective influence of their surroundings operating on the mixture.

* I am unable to discover good grounds for the severity of the criticism, in the name of "the anthropologists," with which Professor Max Müller's assertion that the same blood runs in the veins of English soldiers "as in the veins of the dark Bengalese," and that there is "a legitimate relationship between Hindoo, Greek, and Teuton," has been visited. So far as I know anything about anthropology, I should say that these statements may be correct literally, and probably are so substantially. I do not know of any good reason for the physical differences between a high-caste Hindoo and a Dravidian, except the Aryan blood in the veins of the former; and the strength of the infusion is probably quite as great in some Hindoos as in some English soldiers.

The assumption that, as there must have been a primitive Aryan people, in the philological sense, so that people must have constituted a race in the biological sense, is pretty generally made in modern discussions of the Aryan problem. But whether the men of the primitive Aryan race were blonds or brunets, whether they had long or round heads, were tall or were short, are hotly debated questions into the discussion of which considerations quite foreign to science are sometimes imported. The combination of swarthiness with stature above the average and a long skull, confer upon me the serene impartiality of a mongrel; and, having given this pledge of fair dealing, I proceed to state the case for the hypothesis I am inclined to adopt. In doing so, I am aware that I deliberately take the shilling of the recruiting-sergeant of the Light Brigade, and I warn all and sundry that such is the case.

Looking at the discussions which have taken place from a purely anthropological point of view, the first point which has struck me is that the problem is far more complicated and difficult than many of the disputants appear to imagine; and the second, that the data upon which we have to go are grievously insufficient in extent and in precision. Our historical records cover such an infinitesimally small extent of the past life of humanity, that we obtain little help from them. Even so late as 1500 B. C., northern Eurasia lies in historical darkness, except for such glimmer of light as may be thrown here and there by the literatures of Egypt and of Babylonia. Yet, at that time, it is probable that Sanskrit, Zend, and Greek, to say nothing of other Aryan tongues, had long been differentiated from primitive Aryan. Even a thousand years later, little enough accurate information is to be had about the racial characters of the European and Asiatic tribes known to the Greeks. We are thrown upon such resources as archæology and human palæontology have to offer, and notwithstanding the remarkable progress made of late years, they are still meagre. Nevertheless, it strikes me that, from the purely anthropological side, there is a good deal to be said in favour of the two propositions maintained by the new school of philologists; first, that the people who spoke "primitive Aryan" were a distinct and well-marked race of mankind; and, secondly, that the area of the distribution of this race, in primæval times, lay in Europe, rather than in Asia.

For the last two thousand years, at least, the southern half of Scandinavia and the opposite or southern shores of the Baltic have been occupied by a race of mankind possessed of very definite characters. Typical specimens have tall and massive frames, fair

complexions, blue eyes, and yellow or reddish hair — that is to say, they are pronounced blonds. Their skulls are long, in the sense that the breadth is usually less, often much less, than four-fifths of the length, and they are usually tolerably high. But in this last respect they vary. Men of this blond, long-headed race abound from eastern Prussia to northern Belgium; they are met with in northern France and are common in some parts of our own islands. The people of Teutonic speech, Goths, Saxons, Alemanni, and Franks, who poured forth out of the regions bordering the North Sea and the Baltic, to the destruction of the Roman Empire, were men of this race; and the accounts of the ancient historians of the incursions of the Gauls into Italy and Greece, between the fifth and the second centuries B. C., leave little doubt that their hordes were largely, if not wholly, composed of similar men. The contents of numerous interments in southern Scandinavia prove that, as far back as archæology takes us into the so-called neolithic age, the great majority of the inhabitants had the same stature and cranial peculiarities as at present, though their bony fabric bears marks of somewhat greater ruggedness and savagery. There is no evidence that the country was occupied by men before the advent of these tall, blond long-heads. But there is proof of the presence, along with the latter, of a small percentage of people with broad skulls; skulls, that is, the breadth of which is more, often very much more, than four-fifths of the length.

At the present day, in whatever direction we travel inland from the continental area occupied by the blond long-heads, whether south-west into central France; south, through the Walloon provinces of Belgium into eastern France; into Switzerland, South Germany, and the Tyrol; or south-east, into Poland and Russia; or north, into Finland and Lapland, broad-heads make their appearance, in force, among the long-heads. And, eventually, we find ourselves among people who are as regularly broad-headed as the Swedes and North Germans are long-headed. As a general rule, in France, Belgium, Switzerland, and South Germany, the increase in the proportion of broad skulls is accompanied by the appearance of a larger and larger proportion of men of brunet complexion and of a lower stature; until, in central France and thence eastwards, through the Cevennes and the Alps of Dauphiny, Savoy, and Piedmont, to the western plains of North Italy, the *tall blond long-heads** practically disappear, and are replaced

* I may plead the precedent of the good English words "block-head" and "thick-head" for "broad-head" and "long-head," but I cannot say that they are elegant. I might have employed the technical terms

by *short brunet broad-heads*. The ordinary Savoyard may be described in terms the converse of those which apply to the ordinary Swede. He is short, swarthy, dark-eyed, dark-haired, and his skull is very broad. Between the two extreme types, the one seated on the shores of the North Sea and the Baltic, and the other on those of the Mediterranean, there are all sorts of intermediate forms, in which breadth of skull may be found in tall and in short blond men, and in tall brunet men.

There is much reason to believe that the brunet broad-heads, now met with in central France and in the west central European highlands, have inhabited the same region, not only throughout the historical period, but long before it commenced; and it is probable that their area of occupation was formerly more extensive. For, if we leave aside the comparatively late incursions of the Asiatic races, the centre of eruption of the invaders of the southern moiety of Europe has been situated in the north and west. In the case of the Teutonic inroads upon the Empire of Rome, it undoubtedly lay in the area now occupied by the blond long-heads; and, in that of the antecedent Gaulish invasions, the physical characters ascribed to the leading tribes point to the same conclusion. Whatever the causes which led to the breaking out of bounds of the blond long-heads, in mass, at particular epochs, the natural increase in numbers of a vigorous and fertile race must always have impelled them to press upon their neighbours, and thereby afford abundant occasions for intermixture. If, at any given pre-historic time, we suppose the lowlands verging on the Baltic and the North Sea to have been inhabited by pure blond long-heads, while the central highlands were occupied by pure brunet short-heads, the two would certainly meet and intermix in course of time, in spite of the vast belt of dense forest which extended, almost uninterruptedly, from the Carpathians to the Ardennes; and the result would be such an irregular gradation of the one type into the other as we do, in fact, meet with.

On the south-east, east, and north-east, throughout what was once the kingdom of Poland, and in Finland, the preponderance of broad-heads goes along with a wide prevalence of blond complexion and of good stature. In the extreme north, on the other

brachycephali and dolichocephali. But it cannot be said that they are much more graceful; and, moreover, they are sometimes employed in senses different from that which I have given in the definition of broad-heads and long-heads. The *cephalic index* is a number which expresses the relation of the breadth to the length of a skull, taking the latter as 100. Therefore "broad-heads" have the cephalic index above 80 and "long-heads" have it below 80. The physiological value of the difference is unknown; its morphological value depends upon the observed fact of the constancy of the occurrence of either long skulls or broad skulls among large bodies of mankind.

hand, marked broad-headedness is combined with low stature, swarthiness, and more or less strongly Mongolian features, in the Lapps. And it is to be observed that this type prevails increasingly to the eastward, among the central Asiatic populations.

The population of the British Islands, at the present time, offers the two extremes of the tall blond and the short brunet types. The tall blond long-heads resemble those of the continent; but our short brunet race is long-headed. Brunet broad-heads, such as those met with in the central European highlands, do not exist among us. This absence of any considerable number of distinctly broad-headed people (say with the cephalic index above 81 or 82) in the modern population of the United Kingdom is the more remarkable, since the investigations of the late Dr. Thurnam, and others, proved the existence of a large proportion of tall broad-heads among the people interred in British tumuli of the neolithic age. It would seem that these broad-skulled immigrants have been absorbed by an older long-skulled population; just as, in South Germany, the long-headed Alemanni have been absorbed by the older broad-heads. The short brunet long-heads are not peculiar to our islands. On the contrary, they abound in western France and in Spain, while they predominate in Sardinia, Corsica, and South Italy, and, it may be, occupied a much larger area in ancient times.

Thus, in the region which has been under consideration, there are evidences of the existence of four races of men — (1) blond long-heads of tall stature, (2) brunet broad-heads of short stature, (3) mongoloid brunet broad-heads of short stature, (4) brunet long-heads of short stature. The regions in which these races appear with least admixture are — (1) Scandinavia, North Germany, and parts of the British Islands; (2) central France, the central European highlands, and Piedmont; (3) Arctic and Eastern Europe, central Asia; (4) the western parts of the British Islands and of France; Spain, South Italy. And the inhabitants of the localities which lie between these foci present the intermediate gradations, such as short blond long-heads, and tall brunet short-heads, and long-heads which might be expected to result from their intermixture. The evidence at present extant is consistent with the supposition that the blond long-heads, the brunet broad-heads, and the brunet long-heads, have existed in Europe throughout historic times, and very far back into pre-historic times. There is no proof of any migration of Asiatics into Europe, west of the basin of the Dnieper, down to the time of Attila. On the contrary, the first great movements of the European population of which there is any conclusive evidence is that series of Gaulish

invasions of the east and south, which ultimately extended from North Italy as far as Galatia in Asia Minor.

It is now time to consider the relations between the phenomena of racial distribution, as thus defined, and those of the distribution of languages. The blond long-heads of Europe speak, or have spoken, Lithuanian, Teutonic, or Celtic dialects, and they are not known to have ever used any but these Aryan languages. A large proportion of the brunet broad-heads once spoke the Ligurian and the Rhætic dialects, which are believed to have been non-Aryan. But, when the Romans made acquaintance with Transalpine Gaul, the inhabitants of that country between the Garonne and the Seine (Cæsar's *Celtica*) seem, at any rate for the most part, to have spoken Celtic dialects. The brunet long-heads of Spain and of France appear to have used a non-Aryan language, that Euskarian which still lives on the shores of the Bay of Biscay. In Britain there is no certain knowledge of their use of any but Celtic tongues. What they spoke in the Mediterranean islands and in South Italy does not appear.

The blond broad-heads of Poland and West Russia form part of a people who, when they first made their appearance in history, occupied the marshy plains imperfectly drained by the Vistula, on the west, the Duna, on the north, and the Dnieper and Bug, on the south. They were known to their neighbours as Wends, and among themselves as Serbs and Slavs. The Slavonic languages spoken by these people are said to be most closely allied to that of the Lithuanians, who lay upon their northern border. The Slavs resemble the South Germans in the predominance of broad-heads among them, while stature and complexion vary from the, often tall, blonds who prevail in Poland and Great Russia to the, often short, brunets common elsewhere. There is certainly nothing in the history of the Slav people to interfere with the supposition that, from very early times, they have been a mixed race. For their country lies between that of the tall blond long-heads on the north, that of the short brunet broad-heads of the European type on the west, and that of the short brunet broad-heads of the Asiatic type on the east: and, throughout their history, they have either thrust themselves among their neighbours, or have been overrun and trampled down by them. Gauls and Goths have traversed their country, on their way to the east and south: Finno-tataric people, on their way to the west, have not only done the like, but have held them in subjection for centuries. On the other hand, there have been times when their western frontier advanced beyond the Elbe; indeed, it is asserted that they have

sent colonies to Holland and even as far as southern England. A large part of eastern Germany; Bohemia, Moravia, Hungary; the lower valley of the Danube, and the Balkan peninsula, have been largely or completely Slavonised; and the Slavonic rule and language, which once had trouble to hold their own in West Russia and Little Russia, have now extended their sway over all the Finno-tataric populations of Great Russia; while they are advancing, among those of central Asia, up to the frontiers of India on the south and to the Pacific on the extreme east. Thus it is hardly possible that fewer than three races should have contributed to the formation of the Slavonic people; namely, the blond long-heads, the European brunet broad-heads, and the Asiatic brunet broad-heads. And, in the absence of evidence to the contrary, it is certainly permissible to suppose that it is the first race which has furnished the blond complexion and the stature observable in so many, especially of the northern Slavs, and that the brunet complexion and the broad skulls must be attributed to the other two. But, if that supposition is permissible, then the Aryan form and substance of the Slavonic languages may also be fairly supposed to have proceeded from the blond long-heads. They could not have come from the Asiatic brunet broad-heads, who all speak non-Aryan languages; and the presumption is against their coming from the brunet broad-heads of the central European highlands, among whom an apparently non-Ayran language was largely spoken, even in historical times.

In the same way, the tall blond tribes among the Fins may be accounted for as the product of admixture. The great majority of the Finno-tataric people are brunet broad-heads of the Asiatic type. But that the Fins proper have long been in contact with Aryans is evidenced by the many words borrowed from Aryan which their language contains. Hence there has been abundant opportunity for the mixture of races; and for the transference to some of the Fins of more or fewer of the physical characters of the Aryans and *vice versâ*. On any hypothesis, the frontier between Aryan and Finno-tataric people must have extended across west-central Asia for a very long period; and, at any point of this frontier, it has been possible that mixed races of blond Fins or of brunet Aryans should be formed.

So much for the European people who now speak Celtic, or Teutonic, or Slavonian, or Lithuanian tongues; or who are known to have spoken them, before the supersession of so many of the early native dialects by the Romance modifications of the language of Rome. With respect to the original speakers of Greek and Latin, the unravelling of the tangled ethnology of the Balkan pen-

insula and the ordering of the chaos of that of Italy are enterprises upon which I do not propose to enter. In regard to the first, however, there are a few tolerably satisfactory data. The ancient Thracians were proverbially blue-eyed and fair-haired. Tall blonds were common among the ancient Greeks, who were a long-headed people; and the Sphakiots of Crete, probably the purest representatives of the old Hellenes in existence, are tall and blond. But considering that Greek colonisation was taking place on a great scale in the eighth century B. C., and that, centuries earlier and later, the restless Hellene had been fighting, trading, plundering and kidnapping, on both sides of the Ægean, and perhaps as far as the shores of Syria and of Egypt, it is probable that, even at the dawn of history, the maritime Greeks were a very mixed race. On the other hand, the Dorians may well have preserved the original type; and their famous migration may be the earliest known example of those movements of the Aryan race which were, in later times, to change the face of Europe. Analogy perhaps justifies a guess, that those ethnological shadows, the Pelasgi, may have been an earlier mixed population, like that of Western Gaul and of Britain before the Teutonic invasion. At any rate, the tall blond long-heads are so well represented in the oldest history of the Balkan peninsula, that they may be credited with the Aryan languages spoken there. And it may be that the tradition which peopled Phrygia with Thracians represents a real movement of the Aryan race into Asia Minor, such as that which in after years carried the Gauls thither.

The difficulties in the way of a probable identification of the people among whom the various dialects of the Latin group developed themselves, with any race traceable in Italy in historical times, are very great. In addition to the Italic "aborigines" northern Italy was peopled by Ligurian brunet broad-heads; with Gauls, probably, to a large extent, blond long-heads; with Illyrians, about whom nothing is known. Besides these, there were those perplexing people the Etruscans, who seem to have been, originally, brunet long-heads. South Italy and Sicily present a contingent of "Sikels," Phœnicians and Greeks; while over all, in comparatively modern times, follows a wash of Teutonic blood. The Latin dialects arose, no one knows how, among the tribes of Central Italy, encompassed on all sides by people of the most various physical characters, who were gradually absorbed into the eternally widening maw of Rome, and there, by dint of using the same speech, became the first example of that wonderful ethnological hotch-potch miscalled the Latin race. The only trustworthy guide here is archæological investigation. A great advance will

have been made when the race characters of the pre-historic people of the terramare (who are identified by Helbig* with the primitive Umbrians) become fully known.

I cannot learn that the ancient literatures of India and of Persia give any definite information about the complexion of the Indo-Iranians, beyond conveying the impression that they were what we vaguely call white men. But it is important to note that tall blond people make their appearance sporadically among the Tadjiks of Persia and of Turkestan; that the Siah-posh and Galtchas of the mountainous barrier between Turkestan and India are such; and that the same characters obtain largely among the Kurds on the western frontier of Persia, at the present day. The Kurds and the Galtchas are generally broad-headed, the others are long-headed. These people and the ancient Alans thus form a series of stepping-stones between the blond Aryans of Europe and those of Asia, standing up amidst the flood of Finno-tataric people which has inundated the rest of the interval between the sources of the Dnieper and those of the Oxus. If only more was known about the Sarmatians and the Scythians of the oldest historians, it is not improbable, I think, that we should discover that, even in historical times, the area occupied by the blond long-heads of Aryan speech has been, at least temporarily, continuous from the shores of the North Sea to central Asia.

Suppose it to be admitted, as a fair working hypothesis, that the blond long-heads once extended without a break over this vast area, and that all the Aryan tongues have been developed out of their original speech, the question respecting the home of the race when the various families of Aryan speech were in the condition of inceptive dialects remains open. For all that, at first, appears to the contrary, it may have been in the west, or in the east, or anywhere between the two. In seeking for a solution of this obscure problem, it is an important preliminary to grasp the truth that the Aryan race must be much older than the primitive Aryan speech. It is not to be seriously imagined that the latter sprang suddenly into existence, by the act of a jealous Deity, apparently unaware of the strength of man's native tendency towards confusion of speech. But if all the diverse languages of men were not brought suddenly into existence, in order to frustrate the plans of the audacious bricklayers of the plain of Shinar; if this professedly historical statement is only another "type,"

* *Die Italiker in der Poebene*, 1879. See for much valuable information respecting the races of the Balkan and Italic peninsulæ, Zampa's essay, "Vergleichende Anthropologische Ethnographie von Apulien," *Zeitschrift für Ethnologie*, xviii., 1886.

and primitive Aryan, like all other languages, was built up by a secular process of development, the blond long-heads, among whom it grew into shape, must for ages have been, philologically speaking, non-Aryans, or perhaps one should say "pro-Aryans." I suppose it may be safely assumed that Sanskrit and Zend and Greek were fully differentiated in the year 1500 B. C. If so, how much further back must the existence of the primitive Aryan, from which these proceeded, be dated? And how much further yet, that real *juventus mundi* (so far as man is concerned) when primitive Aryan was in course of formation? And how much further still, the differentiation of the nascent Aryan blond long-head race from the primitive stock of mankind?

If any one maintains that the blond long-headed people, among whom, by the hypothesis, the primitive Aryan language was generated may have formed a separate race as far back as the pleistocene epoch, when the first unquestionable records of man make their appearance, I do not see that he goes beyond possibility — though, of course, that is a very different thing from proving his case. But, if the blond long-heads are thus ancient, the problem of their primitive seat puts on an altogether new aspect. Speculation must take into account climatal and geographical conditions widely different from those which obtain in northern Eurasia at the present day. During much of the vast length of the pleistocene period, it would seem that men could no more have lived either in Britain north of the Thames, or in Scandinavia, or in northern Germany, or in northern Russia, than they can live now in the interior of Greenland, seeing that the land was covered by a great ice sheet like that which at present shrouds the latter country. At that epoch, the blond long-heads cannot reasonably be supposed to have occupied the regions in which we meet with them in the oldest times of which history has kept a record.

But even if we are content to assume a vastly less antiquity for the Aryan race; if we only make the assumption, for which there is considerable positive warranty, that it has existed in Europe ever since the end of the pleistocene period — when the fauna and flora assumed approximately their present condition and the state of things called Recent by geologists set in — we have to reckon with a distribution of land and water, not only very different from that which at present obtains in northern Eurasia, but of such a nature that it can hardly fail to have exerted a great influence on the development and the distribution of the races of mankind.

At the present time four great separate bodies of water, the Black Sea, the Caspian, the Sea of Aral, and Lake Balkash, occupy the southern end of the vast plains which extend from the

Arctic Sea to the highlands of the Balkan peninsula, of Asia Minor, of Persia, of Afghanistan, and of the high plateaus of central Asia as far as the Altai. They lie for the most part between the parallels of 40° and 50° N. and are separated by wide stretches of barren and salt-laden wastes. The surface of Balkash is 514 feet, that of the Aral 158 feet above the Mediterranean, that of the Caspian eighty-five feet below it. The Black Sea is in free communication with the Mediterranean by the Bosphorus and the Dardanelles; but the others, in historical times, have been, at most, temporarily connected with it and with one another, by relatively insignificant channels. This state of things, however, is comparatively modern. At no very distant period, the land of Asia Minor was continuous with that of Europe, across the present site of the Bosphorus, forming a barrier several hundred feet high, which dammed up the waters of the Black Sea. A vast extent of eastern Europe and western central Asia thus became a huge reservoir, the lowest part of the lip of which was probably situated somewhat more than 200 feet above the sea level, along the present southern watershed of the Obi, which flows into the Arctic Ocean. Into this basin, the largest rivers of Europe, such as the Danube and the Volga, and what were then great rivers of Asia, the Oxus and Jaxartes, with all the intermediate affluents, poured their waters. In addition, it received the overflow of Lake Balkash, then much larger; and, probably, that of the inland sea of Mongolia. At that time, the level of the Sea of Aral stood at least 60 feet higher than it does at present.* Instead of the separate Black, Caspian, and Aral seas, there was one vast Ponto-Aralian Mediterranean, which must have been prolonged into arms and fiords along the lower valleys of the Danube, the Volga (in the course of which Caspian shells are now found as far as the Kuma), the Ural, and the other affluent rivers — while it seems to have sent its overflow, northward, through the present basin of the Obi. At the same time, there is reason to believe that the northern coast of Asia, which everywhere shows signs of recent slow upheaval, was situated far to the south of its present position. The consequences of this state of things have an extremely important bearing on the question under discussion. In the first place, an insular climate must be substituted for the present extremely continental climate of west central Eurasia. That is an important fact in many ways. For example, the present eastern climatal limitations of the beech could not have existed, and if primitive Aryan goes back thus far, the arguments based upon

* This is proved by the old shore-marks on the hill of Kashkanatao in the midst of the delta of the Oxus. Some authorities put the ancient level very much higher — 200 feet or more (Keane, *Asia*, p. 408).

the occurrence of its name in some Aryan languages and not in others lose their force. In the second place, the European and the Asiatic moieties of the great Eurasiatic plains were cut off from one another by the Ponto-Aralian Mediterranean and its prolongations. In the third place, direct access to Asia Minor, to the Caucasus, to the Persian highlands, and to Afghanistan, from the European moiety was completely barred; while the tribes of eastern central Asia were equally shut out from Persia and from India by huge mountain ranges and table lands. Thus, if the blond long-head race existed so far back as the epoch in which the Ponto-Aralian Mediterranean had its full extension, space for its development, under the most favourable conditions, and free from any serious intrusion of foreign elements from Asia, was presented in northern and eastern Europe.

When the slow erosion of the passage of the Dardanelles drained the Ponto-Aralian waters into the Mediterranean, they must have everywhere fallen as near the level of the latter as the make of the country permitted, remaining, at first, connected by such straits as that of which the traces yet persist between the Black and the Caspian, the Caspian and the Aral Seas respectively. Then, the gradual elevation of the land of northern Siberia, bringing in its train a continental climate, with its dry air and intense summer heats, the loss by evaporation soon exceeded the greatly reduced supply of water, and Balkash, Aral, and Caspian gradually shrank to their present dimensions. In the course of this process, the broad plains between the separated inland seas, as soon as they were laid bare, threw open easy routes to the Caucasus and to Turkestan, which might well be utilised by the blond long-heads moving eastward through the plains, contemporaneously left dry, south and east of the Ural chain. The same process of desiccation, however, would render the route from east central Asia westward as easily practicable; and, in the end, the Aryan stock might easily be cut in two, as we now find it to be, by the movement of the Mongoloid brunet broad-heads to the west.

Thus we arrive at what is practically Latham's Sarmatian hypothesis — if the term "Sarmatian" is stretched a little, so as to include the higher parts and a good deal of the northern slopes of Europe between the Ural and the German Ocean; an immense area of country, at least as large as that now included between the Black Sea, the Atlantic, the Baltic, and the Mediterranean.

If we imagine the blond long-head race to have been spread over this area, while the primitive Aryan language was in course of formation, its north-western and its south-eastern tribes will have

been 1,500, or more, miles apart. Thus, there will have been ample scope for linguistic differentiation; and, as adjacent tribes were probably influenced by the same causes, it is reasonable to suppose that, at any given region of the periphery the process of differentiation, whether brought about by internal or external agencies, will have been analogous. Hence, it is permissible to imagine that, even before primitive Aryan had attained its full development, the course of that development had become somewhat different in different localities; and, in this sense, it may be quite true that one uniform primitive Aryan language never existed. The nascent mode of speech may very early have got a twist, so to speak, towards Lithuanian, Slavonian, Teutonic, or Celtic, in the north and west; towards Thracian and Greek, in the south-west; towards Armenian in the south; towards Indo-Iranian in the south-east. With the centrifugal movements of the several fractions of the race, these tendencies of peripheral groups would naturally become more and more intensified in proportion to their isolation. No doubt, in the centre and in other parts of the periphery of the Aryan region, other dialectic groups made their appearance; but whatever development they may have attained, these have failed to maintain themselves in the battle with the Finno-tataric tribes, or with the stronger among their own kith and kin.*

Thus I think that the most plausible hypothetical answers which can be given to the two questions which we put at starting are these. There was and is an Aryan race — that is to say, the characteristic modes of speech, termed Aryan, were developed among the blond long-heads alone, however much some of them may have been modified by the importation of non-Aryan elements. As to the "home" of the Aryan race, it was in Europe, and lay chiefly east of the central highlands and west of the Ural. From this region it spread west, along the coasts of the North Sea to our islands, where, probably, it met the brunet long-heads; to France, where it found both these and the brunet short-heads; to Switzerland and South Germany, where it impinged on the brunet short-heads; to Italy, where brunet short-heads seem to have abounded in the north and long-heads in the south; and to the Balkan peninsula, about the earliest inhabitants of which we know next to nothing. There are two ways to Asia Minor, the one over the Bosphorus and the other through the passes of the Caucasus, and the Aryans may well have utilised both. Finally, the south-

* See the views of J. Schmidt (stated and discussed in Schrader and Jevons, pp. 63-67), with which those here set forth are substantially identical.

eastern tribes probably spread themselves gradually over west Turkestan, and, after evolving the primitive Indo-Iranian dialect, eventually colonised Persia and Hindostan, where their speech developed into its final forms. On this hypothesis, the notion that the Celts and the Teutons migrated from about Pamir and the Hindoo-Koosh is as far from the truth as the supposition that the Indo-Iranians migrated from Scandinavia. It supposes that the blond long-heads, in what may be called their nascent Aryan stage, that is before their dialects had taken on the full Aryan characteristics, were spread over a wide region which is, conventionally, European; but which, from the point of view of the physical geographer, is rather to be regarded as a continuation of Asia. Moreover, it is quite possible and even probable, that the blond long-heads may have arrived in Turkestan before their language had reached, or at any rate passed beyond, the stage of primitive Aryan; and that the whole process of differentiation into Indo-Iranian took place during the long ages of their residence in the basin of the Oxus. Thus, the question whether the seat of the primitive Aryans was in Europe, or in Asia, becomes very much a debate about geographical terminology.

The foregoing arguments in favour of Latham's "Sarmatian hypothesis" have been based upon data which lie within the ken of history or may be surely concluded by reasoning backwards from the present state of things. But, thanks to the investigations of the pre-historic archæologists and anthropologists during the last half century, a vast mass of positive evidence respecting the distribution and the condition of mankind in the long interval between the dawn of history and the commencement of the recent epoch has been brought to light.

During this period, there is evidence that men existed in all those regions of Europe which have yet been properly examined; and such of their bony remains as have been discovered exhibit no less diversity of stature and cranial conformation than at present. There are tall and short men; long-skulled and broad-skulled men; and it is probably safe to conclude that the present contrast of blonds and brunets existed among them when they were in the flesh. Moreover, it has become clear that, everywhere, the oldest of these people were in the so-called neolithic stage of civilisation. That is to say, they not merely used stone implements which were chipped into shape, but they also employed tools and weapons brought to an edge by grinding. At first they know little or nothing of the use of metals; they possess domestic animals and cultivated plants and live in houses of simple construction.

In some parts of Europe little advance seems to have been made, even down to historical times. But in Britain, France, Scandinavia, Germany, Western Russia, Switzerland, Austria, the plain of the Po, very probably also in the Balkan peninsula, culture gradually advanced until a relatively high degree of civilisation was attained. The initial impulse in this course of progress appears to have been given by the discovery that metal is a better material for tools and weapons than stone. In the early days of pre-historic archæology, Nilsson showed that, in the interments of the middle age, bronze largely took the place of stone, and that, only in the latest, was iron substituted for bronze. Thus arose the generalisation of the occurrence of a regular succession of stages of culture, which were somewhat unfortunately denominated the "ages" of stone, bronze, and iron. For a long time after this order of succession in the same locality (which, it was sometimes forgotten, has nothing to do with chronological contemporaneity in different localities) was made out, the change from stone to bronze was ascribed to foreign, and, of course, Eastern influences. There were the ubiquitous Phœnician traders and the immigrant Aryans from the Hindoo-Koosh, ready to hand. But further investigation has proved* for various parts of Europe and made it probable for others, that though the old order of succession is correct it is incomplete, and that a copper stage must be interpolated between the neolithic and the bronze stages. Bronze is an artificial product the formation of which implies a knowledge of copper; and it is certain that copper was, at a very early period, smelted out of the native ores, by the people of central Europe who used it. When they learned that the hardness and toughness of their metal were immensely improved by alloying it with a small quantity of tin, they forsook copper for bronze, and gradually attained a wonderful skill in bronze-work. Finally, some of the European people became acquainted with iron, and its superior qualities drove out bronze, as bronze had driven out stone, from use in the manufacture of implements and weapons of the best class. But the process of substitution of copper and bronze for stone was gradual, and, for common purposes, stone remained in use long after the introduction of metals.

The pile-dwellings of Switzerland have yielded an unbroken archæological record of these changes. Those of eastern Switzerland ceased to exist soon after the appearance of metals, but in those of the Lakes of Neuchatel and Bienne the history is con-

* "Proved" is perhaps too strong a word. But the evidence set forth by Dr. Much (*Die Kupferzeit in Europa*, 1886) in favour of a copper stage of culture among the inhabitants of the pile-dwellings is very weighty.

tinued through the stage of bronze to the beginning of that of iron. And in all this long series of remains, which lay bare the minutest details of the life of the pile-dwellers, from the neolithic to the perfected bronze stage, there is no indication of any disturbance such as must have been caused by foreign invasion; and such as was produced by intruders, shortly after the iron stage was reached. Undoubtedly the constructors of the pile-dwellings must have received foreign influences through the channel of trade, and may have received them by the slow immigration of other races. Their amber, their jade, and their tin show that they had commercial intercourse with somewhat distant regions. The amber, however, takes us no further than the Baltic; and it is now known that jade is to be had within the boundaries of Europe, while tin lay no further off than north Italy. An argument in favour of oriental influence has been based upon the characters of certain of the cultivated plants and domesticated animals. But even that argument does not necessarily take us beyond the limits of south-eastern Europe; and it needs reconsideration in view of the changes of physical geography and of climate to which I have drawn attention.

In connection with this question there is another important series of facts to be taken into consideration. When, in the seventeenth century, the Russians advanced beyond the Ural and began to occupy Siberia, they found that the majority of the natives used implements of stone and bone. Only a few possessed tools or weapons of iron, which had reached them by way of commerce; the Ostiaks and the Tartars of Tom, alone, extracted their iron from the ore. It was not until the invaders reached the Lena, in the far east, that they met with skilful smiths among the Jakuts,* who manufactured knives, axes, lances, battle-axes, and leather jerkins studded with iron; and among the Tunguses and Lamuts, who had learned from the Jakuts.

But there is an older chapter of Siberian history which was closed in the seventeenth century, as that of the people of the pile-dwellings of Switzerland had ended when the Romans entered Helvetia. Multitudes of sepulchral tumuli, termed like those of European Russia, "kurgans," are scattered over the north Asiatic plains, and are especially agglomerated about the upper waters of the Jenisei. Some are modern, while others, extremely ancient, are attributed to a quasi-mythical people, the Tschudes.

* Andree, *Die Metalle bei den Naturvölkern* (p. 114). It is interesting to note that the Jakuts have always been pastoral nomads, formerly shepherds, now horse-breeders, and that they continue to work their iron in the primitive fashion; as the argument that metallurgic skill implies settled agricultural life not unfrequently makes its appearance.

These Tschudish kurgans abound in copper and gold articles of use and luxury, but contain neither bronze nor iron. The Tschudes procured their copper and their gold from the metalliferous rocks of the Ural and the Altai; and their old shafts, adits, and rubbish heaps led the Russians to the rediscovery of the forgotten stores of wealth. The race to which the Tschudes belonged and the age of the works which testify to their former existence, are alike unknown. But seeing that a rumour of them appears to have reached Herodotus, while, on the other hand, the pile-dwelling civilization of Switzerland may perhaps come down as late as the fifth century B. C., the possibility that a knowledge of the technical value of copper may have travelled from Siberia westward must not be overlooked. If the idea of turning metals to account must needs be Asiatic, it may be north Asiatic just as well as south Asiatic. In the total absence of trustworthy, chronological and anthropological data, speculation may run wild.

The oldest civilisations for which we have an, even approximately, accurate chronology are those of the valleys of the Nile and of the Euphrates. Here, culture seems to have attained a degree of perfection, at least as high as that of the bronze stage, six thousand years ago. But before the intermediation of Etruscan, Phœnician, and Greek traders, there is no evidence that they exerted any serious influence upon Europe or northern Asia. As to the old civilisation of Mesopotamia, what is to be said until something definite is known about the racial characters of its originators, the Accadians? As matters stand, they are just as likely to have been a group of the same race as the Egyptians, or the Dravidians, as anything else. And considering that their culture developed in the extreme south of the Euphrates valley, it is difficult to imagine that its influence could have spread to northern Eurasia except by the Phœnician (and Carian?) intermediation which was undoubtedly operative in comparatively late times.

Are we then to bring down the discovery of the use of copper in Switzerland to, at earliest, 1500 B. C., and to put it down to Phœnician hints? But why copper? At that time the Phœnicians must have been familiar with the use of bronze. And if, on the other hand, the northern Eurasiatics had got as far as copper, by the help of their own ingenuity, why deny them the capacity to make the further step to bronze? Carry back the borrowing system as far as we may, in the end we must needs come to some man or men from whom the novel idea started, and who after many trials and errors gave it practical shape. And there really is no ground in the nature of things for supposing that such men

of practical genius may not have turned up, independently, in more races than one.

The capacity of the population of Europe for independent progress while in the copper and early bronze stage — the "palæo-metallic" stage, as it might be called — appears to me to be demonstrated in a remarkable manner by the remains of their architecture. From the crannog to the elaborate pile-dwelling, and from the rudest enclosure to the complex fortification of the terramare, there is an advance which is obviously a native product. So with the sepulchral constructions; the stone cist, with or without a preservative, or memorial cairn, grows into the chambered graves lodged in tumuli; into such megalithic edifices as the dromic vaults of Maes How and New Grange; to culminate in the finished masonry of the tombs of Mycenæ, constructed on exactly the same plan. Can any one look at the varied series of forms which lie between the primitive five or six flat stones fitted together into a mere box, and such a building as Maes How, and yet imagine that the latter is the result of foreign tuition? But the men who built Maes How, without metal tools, could certainly have built the so-called "treasure-house" of Mycenæ, with them.

If these old men of the sea, the heights of Hindoo-Koosh-Pamir and the plain of Shinar, had been less firmly seated upon the shoulders of anthropologists, I think they would long since have seen that it is at least possible that the early civilisation of Europe is of indigenous growth; and that, so far as the evidence at present accumulated goes, the neolithic culture may have attained its full development, copper may have gradually come into use, and bronze may have succeeded copper, without foreign intervention.

So far as I am aware, every raw material employed in Europe up to the Palæo-metallic stage, is to be found within the limits of Europe; and there is no proof that the old races of domesticated animals and plants could not have been developed within these limits. If any one chose to maintain, that the use of bronze in Europe originated among the inhabitants of Etruria and radiated thence, along the already established lines of traffic to all parts of Europe, I do not see that his contention could be upset. It would be hard to prove either that the primitive Etruscans could not have discovered the way to manufacture bronze, or that they did not discover it and become a great mercantile people in consequence, before Phœnician commerce had reached the remote shores of the Tyrrhene Sea.

Can it be safely concluded that the palæo-metallic culture which we have been considering was the appanage of any one of the

western Eurasiatic races rather than another? Did it arise and develop among the brunet or the blond long-heads, or among the brunet short-heads? I do not think there are any means of answering these questions, positively, at present. Schrader has pointed out that the state of culture of the primitive Aryans, deduced from philological data, closely corresponds with that which obtained among the pile-dwellers in the neolithic stage. But the resemblance of the early stages of civilisation among the most different and widely separated races of mankind, should warn us that archæology is no more a sure guide in questions of race than philology.

With respect to the osteological characters of the people of the Swiss pile-dwellings information is as yet scanty. So far as the present evidence goes, they appear to have comprised both broad-heads and long-heads, of moderate stature.* In France, England, and Germany, both long and broad skulls are found in tumuli belonging to the neolithic stage. In some parts of England the long skulls, and in others the broad skulls, accompany the higher stature. In the Scandinavian peninsula, nine-tenths of the neolithic people are decided long-heads: in Denmark, there is a much larger proportion of broad-heads.

In view of all the facts known to me (which cannot be stated in greater detail in this place), I am disposed to think that the blond long-heads, the brunet long-heads, and the brunet broad-heads have existed on the continent of Europe throughout the Recent period: that only the former two at first inhabited our islands; but that a mixed race of tall broad-heads, like some of the Black-foresters of the present day, so excellently described by Ecker, migrated from the continent and formed that tall contingent of the population which has been identified (rightly or wrongly) with the Belgæ by Thurman and which seems to have subsequently lost itself among the predominant brunet and blond long-heads.

I do not think there is anything to warrant the conclusion that the palæo-metallic culture of Europe took its origin among the blond long-heads (or supposed Aryan) race; or that the people of the Swiss pile-dwellings belonged to that race. The long-heads

* Professor Virchow has guardedly expressed the opinion that the oldest inhabitants of the Swiss pile-dwellings were broad-heads, and that later on (commencing before the bronze stage) there was a gradual infusion of long-heads among them (*Zeitschrift für Ethnologie*, xvii., 1885). There is independent evidence of the existence of broad-heads in the Cevennes during the neolithic period, and I should be disposed to think that this opinion may well be correct; but the examination of the evidence on which it is, at present, based does not lead me to feel very confident about it.

among them may just as likely have been brunets. In north-eastern Italy there is clear evidence of the superposition of at least four stages of culture, in which that of the copper and bronze using terramare people comes second; a stage marked by Etruscan domination occupies the third place; and that is followed by the stage which appertains to the Gauls, with their long swords and other characteristic iron work. In western Switzerland, on the other hand, at La Tène, and elsewhere, similar relics show that the Gauls followed upon the latest population of the pile-dwellings among whom traces of Etruscan influence (though not of dominion) are to be found. Helbig supposes the terramare people to have been Greco-Latin-speaking Pelasgi, and consequently Aryan. But we cannot suppose the people of the pile-dwellings of Switzerland to have been speakers of primitive Greco-Latin (if ever there was such a language). And if the Gauls were the first speakers of Celtic who got into Switzerland, what Aryan language can the people of the pile-dwellings have spoken?*

As I have already mentioned, there is not the least doubt that man existed in north-western Europe during the Pleistocene or Quaternary epoch. It is not only certain that men were contemporaries of the mammoth, the hairy rhinoceros, the reindeer, the cave bear, and other great carnivora, in England and in France, but a great deal has been ascertained about the modes of life of our predecessors. They were savage hunters, who took advantage of such natural shelters as overhanging rocks and caves, and perhaps built themselves rough wigwams; but who had no domestic animals and have left no sign that they cultivated plants. In many localities there is evidence that a very considerable interval — the so-called *hiatus* — intervened between the time when the Quaternary or palæolithic men occupied particular caves and river basins and the accumulation of the debris left by their neolithic successors. And, in spite of all the warnings against negative evidence afforded by the history of geology, some have very positively asserted that this means a complete break between the Quaternary and the Recent populations — that the Quaternary population followed the retreating ice northwards and left behind them a desert which remained unpeopled for ages. Other high authorities, on the contrary, have maintained that the races of men who now inhabit Europe may all be traced back to the Great Ice Age. When a conflict of opinion of this kind obtains

* See Dr. Munro's excellent work, *The Lake Dwellings of Europe*, for La Tène. Readers of Professor Rhys' recent articles (*Scottish Review*, 1890), may suggest that the pile-dwelling people spoke the Gaedhelic form of Celtic, and the Gauls the Brythonic form.

among reasonable and instructed men, it is generally a safe conclusion that the evidence for neither view is worth much. Certainly that is the result of my own cogitations with regard to both the hiatus doctrine (in its extreme form) and its opposite — though I think the latter by much the more likely to turn out right. But I hesitate to adopt it on the evidence which has been obtained up to this time.

No doubt, human bones and skulls of various types have been discovered in close proximity to palæolithic implements and to skeletons of quaternary quadrupeds; no doubt, if the bones and skulls in question were not human, their contemporaneity would hardly have been questioned. But, since they are human, the demand for further evidence really need not be ascribed to mere conservative prejudice. Because the human biped differs from all other bipeds and quadrupeds, in the tendency to put his dead out of sight in various ways; commonly by burial. It is a habit worthy of all respect in itself, but generative of subtle traps and grievous pitfalls for the unwary investigator of human palæontology. For it may easily happen, that the bones of him that "died o' Wednesday," may thus come to lie alongside the bones of animals that were extinct thousands of years before that Wednesday; and yet the interment may have been effected so many thousands of years ago that no outward sign betrays the difference in date. In all investigations of this kind, the most careful and critical study of the circumstances is needful if the results are to be accepted as perfectly trustworthy.

In the case of the remains found in a cave of the valley of the Neander, near Düsseldorf, half a century ago — the characters of which gave rise to a vast amount of discussion at that time and subsequently — the circumstances of the discovery were but vaguely known. The skeleton was met with in a deposit, the loess, which is known to be of quaternary age; there was no evidence to show how it came there. Consequently, not only was its exact age justly and properly declared to be a matter of doubt; but those who, on scientific or other grounds, were inclined to minimise its importance could put forth plausible speculations about its nature which do not look so well under the light thrown by a more advanced science of Anthropology. It could be and it was suggested that the Neanderthal skeleton was that of a strayed idiot; that the characters of the skull were the result of early synostosis or of late gout; and, in fact, any stick was good enough to beat the dog withal.

As some writings of mine on the subject led to my occupation of a prominent position among the belaboured dogs of that day,

I have taken a mild interest in watching the gradual rehabilitation of my old friend of the Neanderthal among normal men, which has been going on of late years. It has come to be generally admitted that his remarkable cranium is no more than a strongly-marked example of a type which occurs, not only among other prehistoric men, but is met with, sporadically, among the moderns; and that, after all, I was not so wrong as I ought to have been, when I indicated such points of similarity among the skulls found in our river-beds and among the native races of Australia. However, doubts still clung about the geological age of the various deposits in which skulls of the Neanderthal type were subsequently found; and it was not until the year 1886 that two highly-competent observers, Messrs. Fraipont and Lohest, the one an anatomist, the other a geologist, furnished us with evidence such as will bear severe criticism. At the mouth of a cave in the commune of Spy, in the Belgian province of Namur, Messrs. Fraipont and Lohest discovered two skeletons of the Neanderthal type; and the elaborate account of their investigations which they have published appears to me to leave little room for doubt that the men of Spy fabricated the palæolithic implements, and were the contemporaries of the characteristic quaternary quadrupeds, found with them. The anatomical characters of the skeletons bear out conclusions which are not flattering to the appearance of the owners. They were short of stature but powerfully built, with strong, curiously-curved thigh-bones, the lower ends of which are so fashioned that they must have walked with a bend at the knees. Their long depressed skulls had very strong brow ridges; their lower jaws, of brutal depth and solidity, sloped away from the teeth downwards and backwards, in consequence of the absence of that especially characteristic feature of the higher type of man, the chin prominence. Thus these skulls are not only eminently "Neanderthaloid," but they supply the proof that the parts wanting in the original specimen harmonised in lowness of type with the rest.

After a very full discussion of the anatomical characters of these skulls, M. Fraipont says:

> To sum up, we consider ourselves to be in a position to say that, having regard merely to the anatomical structure of the man of Spy, he possessed a greater number of pithecoid characters than any other race of mankind.*

* Fraipont et Lohest. "La Race humaine de Néanderthal, ou de Canstatt, en Belgique," *Archives de Biologie*, 1886.

And after enumerating these he continues:

> The other and much more numerous characters of the skull, of the trunk, and of the limbs seem to be all human. Between the man of Spy and an existing anthropoid ape there lies an abyss.

Now that is pleasant reading for me, because, in 1863, I committed myself to the assertion that the Neanderthal skull was "the most pithecoid of human crania yet discovered," yet that "in no sense can the Neanderthal bones be regarded as the remains of a human being intermediate between men and apes" and "that the fossil remains of Man hitherto discovered do not seem to me to take us appreciably nearer to that lower pithecoid form, by the modification of which he has, probably, become what he is."

As the evidence stood seven and twenty years ago, in fact, it would have been imprudent to assume that the Neanderthal skull was anything but a case of sporadic reversion. But, in my anxiety not to overstate my case, I understated it. The Neanderthaloid race is "appreciably nearer," though the approximation is but slight. In the words of M. Fraipont:

> The distance which separates the man of Spy from the modern anthropoid ape is undoubtedly enormous; between the man of Spy and the *Dryopithecus* it is a little less. But we must be permitted to point out that if the man of the later quaternary age is the stock whence existing races have sprung, he has travelled a very great way.
>
> From the data now obtained, it is permissible to believe that we shall be able to pursue the ancestral type of men and the anthropoid apes still further, perhaps as far as the eocene and even beyond.*

These conclusions hold good whatever the age of the men of Spy; but they possess a peculiar interest if we admit, as I think on the evidence must be admitted, that these human fossils are of pleistocene age. For, after all due limitations, they give us some, however dim, insight into the rate of evolution of the human species, and indicate that it has not taken place at a much faster or slower pace than that of other mammalia. And if that is so, we are warranted in the supposition that the genus *Homo*, if not the species which the courtesy or the irony of naturalists has dubbed *sapiens*, was represented in pliocene, or even in mio-

* "Where, then, must we look for primæval Man? Was the oldest *Homo sapiens*, pliocene or miocene, or yet more ancient? In still older strata do the fossilised bones of an Ape more anthropoid or a Man more pithecoid than any yet known await the researches of some unborn palæontologist?" p. 121 *supra*.

cene times. But I do not know by what osteological peculiarities it could be determined whether the pliocene, or miocene, man was sufficiently sapient to speak or not;* and whether, or not, he answered to the definition "rational animal" in any higher sense than a dog or an ape does.

There is no reason to suppose that the genus *Homo* was confined to Europe in the pleistocene age; it is much more probable that this, like other mammalian genera of that period, was spread over a large extent of the surface of the globe. At that time, in fact, the climate of regions nearer the equator must have been far more favourable to the human species; and it is possible that, under such conditions, it may have attained a higher development than in the north. As to where the genus *Homo* originated, it is impossible to form even a probable guess. During the miocene epoch, one region of the present temperate zones would serve as well as another. The elder Agassiz long ago tried to prove that the well-marked areas of geographical distribution of mammals have their special kinds of men; and, though this doctrine cannot be made good to the extent which Agassiz maintained, yet the limitation of the Australian type to New Holland,† the approximate restriction of the negro type to Ultra-Saharal Africa, and the peculiar character of the population of Central and South America, are facts which bear strongly in favour of the conclusion that the causes which have influenced the distribution of mammals in general have powerfully affected that of man.

Let it be supposed that the human remains from the caves of the Neanderthal and of Spy represent the race, or one of the races, of men who inhabited Europe in the quaternary epoch, can any connection be traced between it and existing races? That is to say, do any of them exhibit characters approximating those of the Spy men or other examples of the Neanderthaloid race? Put in the latter form, I think that the question may be safely answered in the affirmative. Skulls do occasionally approach the Neanderthaloid type, among both the brunet and the blond long-head races. For the former, I pointed out the resemblance, long ago, in some of the Irish river-bed skulls. For the latter, evidence of various kinds may be adduced; but I prefer to cite the authority of one of the most accomplished and cautious of living anthropologists. Professor Virchow was led, by historical con-

* I am perplexed by the importance attached by some to the presence or absence of the so-called "genial" elevations. Does any one suppose that the existence of the genio-hyo-glossus muscle, which plays so large a part in the movements of the tongue, depends on that of these elevations?

[† Unless I am right in extending it to Hindostan and even further west.— 1894.]

siderations, to think that the Teutonic type, if it still remained pure and undefiled anywhere, should be discoverable among the Frisians, in their ancient island homes on the North German coast, remote from the great movements of nations. In their tall stature and blond complexion the Frisians fulfilled expectation; but their skulls differed in some respects from those of the neighbouring blond long-heads. The depression, or flattening (accompanied by a slight increase in breadth), which occurs occasionally among the latter, is regular and characteristic among the Frisians; and, in other respects, the Frisian skull unmistakably approaches the Neanderthal and Spy type.* The fact that this resemblance exists is of none the less importance because the proper interpretation of it is not yet clear. It may be taken to be a pretty sure indication of the physiological continuity of the blond long-heads with the pleistocene Neanderthaloid men. But this continuity may have been brought about in two ways. The blond long-heads may exhibit one of the lines of evolution of the men of the Neanderthaloid type. Or, the Frisians may be the result of the admixture of the blood long-heads with Neanderthaloid men; whose remains have been found at Canstatt and at Gibraltar, as well as at Spy and in the valley of the Neander; and who, therefore, seem, at one time, to have occupied a considerable area in Western Europe. The same alternatives present themselves when Neanderthaloid characters appear in skulls of other races. If these characters belong to a stage in the development of the human species, antecedent to the differentiation of any of the existing races, we may expect to find them in the lowest of these races, all over the world, and in the early stages of all races. I have already referred to the remarkable similarity of the skulls of certain tribes of native Australians to the Neanderthal skull; and I may add, that the wide differences in height between the skulls of different tribes of Australians afford a parallel to the differences in altitude between the skulls of the men of Spy and those of the grave rows of North Germany. Neanderthaloid features are to be met with, not only in ancient long skulls; those of the ancient broad-headed people entombed at Borreby in Denmark have been often noted.

Reckoned by centuries, the remoteness of the quaternary, or pleistocene, age from our own is immense, and it is difficult to form an adequate notion of its duration. Undoubtedly there is

* Virchow *Beiträge zur physischen Anthropologie der Deutschen* (*Abh. der Königlichen Akademie der Wissenschaften zu Berlin*, 1876). See particularly p. 238 for the full recognition of the Neanderthaloid characters of Frisian skulls and of the ethnological significance of the similarity.

an abysmal difference between the Neanderthaloid race and the comely living specimens of the blond long-heads with whom we are familiar. But the abyss of time between the period at which North Europe was first covered with ice, when savages pursued mammoths and scratched their portraits with sharp stones in central France, and the present day, ever widens as we learn more about the events which bridge it. And, if the differences between the Neanderthaloid men and ourselves could be divided into as many parts as that time contains centuries, the progress from part to part would probably be almost imperceptible.

THE END.

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Science and Education

ESSAYS

By Thomas H. Huxley

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SCIENCE AND EDUCATION.

I.

JOSEPH PRIESTLEY.

IF the man to perpetuate whose memory we have this day raised a statue had been asked on what part of his busy life's work he set the highest value, he would undoubtedly have pointed to his voluminous contributions to theology. In season and out of season, he was the steadfast champion of that hypothesis respecting the Divine nature which is termed Unitarianism by its friends and Socinianism by its foes. Regardless of odds, he was ready to do battle with all comers in that cause; and if no adversaries entered the lists, he would sally forth to seek them.

To this, his highest ideal of duty, Joseph Priestley sacrificed the vulgar prizes of life, which, assuredly, were within easy reach of a man of his singular energy and varied abilities. For this object he put aside, as of secondary importance, those scientific investigations which he loved so well, and in which he showed himself so competent to enlarge the boundaries of natural knowledge and to win fame. In this cause he not only cheerfully suffered obloquy from the bigoted and the unthinking, and came within sight of martyrdom; but bore with that which is much harder to be borne than all these, the unfeigned astonishment and hardly disguised contempt of a brilliant society, composed of men whose sympathy and esteem must have been most dear to him, and to whom it was simply incomprehensible that a philosopher should seriously occupy himself with any form of Christianity.

It appears to me that the man who, setting before himself such an ideal of life, acted up to it consistently, is worthy of the deepest respect, whatever opinion may be entertained as to the real value of the tenets which he so zealously propagated and defended.

But I am sure that I speak not only for myself, but for all this assemblage, when I say that our purpose to-day is to do honour, not to Priestley, the Unitarian divine, but to Priestley, the fearless defender of rational freedom in thought and in action: to Priestley, the philosophic thinker; to that Priestley who held a

foremost place among "the swift runners who hand over the lamp of life," and transmit from one generation to another the fire kindled, in the childhood of the world, at the Promethean altar of Science.

The main incidents of Priestley's life are so well known that I need dwell upon them at no great length.

Born in 1733, at Fieldhead, near Leeds, and brought up among Calvinists of the straitest orthodoxy, the boy's striking natural ability led to his being devoted to the profession of a minister of religion; and, in 1752, he was sent to the Dissenting Academy at Daventry — an institution which authority left undisturbed, though its existence contravened the law. The teachers under whose instruction and influence the young man came at Daventry, carried out to the letter the injunction to "try all things: hold fast that which is good," and encouraged the discussion of every imaginable proposition with complete freedom, the leading professors taking opposite sides; a discipline which, admirable as it may be from a purely scientific point of view, would seem to be calculated to make acute, rather than sound, divines. Priestley tells us, in his "Autobiography," that he generally found himself on the unorthodox side: and, as he grew older, and his faculties attained their maturity, this native tendency towards heterodoxy grew with his growth and strengthened with his strength. He passed from Calvinism to Arianism; and finally, in middle life, landed in that very broad form of Unitarianism by which his craving after a credible and consistent theory of things was satisfied.

On leaving Daventry Priestley became minister of a congregation, first at Needham Market, and secondly at Nantwich; but whether on account of his heterodox opinions, or of the stuttering which impeded his expression of them in the pulpit, little success attended his efforts in this capacity. In 1761, a career much more suited to his abilities became open to him. He was appointed "tutor in the languages" in the Dissenting Academy at Warrington, in which capacity, besides giving three courses of lectures, he taught Latin, Greek, French, and Italian, and read lectures on the theory of language and universal grammar, on oratory, philosophical criticism, and civil law. And it is interesting to observe that, as a teacher, he encouraged and cherished in those whom he instructed freedom which he had enjoyed, in his own student days, at Daventry. One of his pupils tells us that,

"At the conclusion of his lecture, he always encouraged his students to express their sentiments relative to the subject of it, and to urge any

objections to what he had delivered, without reserve. It pleased him when any one commenced such a conversation. In order to excite the freest discussion, he occasionally invited the students to drink tea with him, in order to canvass the subjects of his lectures. I do not recollect that he ever showed the least displeasure at the strongest objections that were made to what he delivered, but I distinctly remember the smile of approbation with which he usually received them; nor did he fail to point out, in a very encouraging manner, the ingenuity or force of any remarks that were made, when they merited these characters. His object, as well as Dr. Aikin's, was to engage the students to examine and decide for themselves, uninfluenced by the sentiments of any other persons."

It would be difficult to give a better description of a model teacher than that conveyed in these words.

From his earliest days, Priestley had shown a strong bent towards the study of nature; and his brother Timothy tells us that the boy put spiders into bottles, to see how long they would live in the same air — a curious anticipation of the investigations of his later years. At Nantwich, where he set up a school, Priestley informs us that he bought an air pump, an electrical machine, and other instruments, in the use of which he instructed his scholars. But he does not seem to have devoted himself seriously to physical science until 1766, when he had the great good fortune to meet Benjamin Franklin, whose friendship he ever afterwards enjoyed. Encouraged by Franklin, he wrote a "History of Electricity," which was published in 1767, and appears to have met with considerable success.

In the same year, Priestley left Warrington to become the minister of a congregation at Leeds; and, here, happening to live next door to a public brewery, as he says,

"I, at first, amused myself with making experiments on the fixed air which I found ready-made in the process of fermentation. When I removed from that house I was under the necessity of making fixed air for myself; and one experiment leading to another, as I have distinctly and faithfully noted in my various publications on the subject, I by degrees contrived a convenient apparatus for the purpose, but of the cheapest kind.

"When I began these experiments I knew very little of *chemistry*, and had, in a manner, no idea on the subject before I attended a course of chemical lectures, delivered in the Academy at Warrington, by Dr. Turner of Liverpool. But I have often thought that, upon the whole, this circumstance was no disadvantage to me; as, in this situation, I was led to devise an apparatus and processes of my own, adapted to my peculiar views; whereas, if I had been previously accustomed to the usual chemical processes, I should not have so easily thought of any other, and without new modes of operation, I should hardly have discovered anything materially new."

The first outcome of Priestley's chemical work, published in 1772, was of a very practical character. He discovered the way of impregnating water with an excess of "fixed air," or carbonic acid, and thereby producing what we now know as "soda water" —a service to naturally, and still more to artificially, thirsty souls, which those whose parched throats and hot heads are cooled by morning draughts of that beverage, cannot too gratefully acknowledge. In the same year, Priestley communicated the extensive series of observations which his industry and ingenuity had accumulated, in the course of four years, to the Royal Society, under the title of "Observations on Different Kinds of Air" —a memoir which was justly regarded of so much merit and importance, that the Society at once conferred upon the author the highest distinction in their power, by awarding him the Copley Medal.

In 1771 a proposal was made to Priestley to accompany Captain Cook in his second voyage to the South Seas. He accepted it, and his congregation agreed to pay an assistant to supply his place during his absence. But the appointment lay in the hands of the Board of Longitude, of which certain clergymen were members; and whether these worthy ecclesiastics feared that Priestley's presence among the ship's company might expose His Majesty's sloop *Resolution* to the fate which aforetime befell a certain ship that went from Joppa to Tarshish; or whether they were alarmed lest a Socinian should undermine that piety which, in the days of Commodore Trunnion, so strikingly characterised sailors, does not appear; but, at any rate, they objected to Priestley "on account of his religious principles," and appointed the two Forsters, whose "religious principles," if they had been known to these well-meaning but not far-sighted persons, would probably have surprised them.

In 1772 another proposal was made to Priestley. Lord Shelburne, desiring a "literary companion," had been brought into communication with Priestley by the good offices of a friend of both, Dr. Price; and offered him the nominal post of librarian, with a good house and appointments, and an annuity in case of the termination of the engagement. Priestley accepted the offer, and remained with Lord Shelburne for seven years, sometimes residing at Calne, sometimes travelling abroad with the Earl.

Why the connection terminated has never been exactly known; but it is certain that Lord Shelburne behaved with the utmost consideration and kindness towards Priestley; that he fulfilled his engagements to the letter; and that, at a later period, he expressed a desire that Priestley should return to his old footing in

his house. Probably enough, the politician, aspiring to the highest offices in the State, may have found the position of the protector of a man who was being denounced all over the country as an infidel and an atheist somewhat embarrassing. In fact, a passage in Priestley's "Autobiography" on the occasion of the publication of his "Disquisitions relating to Matter and Spirit," which took place in 1777, indicates pretty clearly the state of the case:—

"(126) It being probable that this publication would be unpopular, and might be means of bringing odium on my patron, several attempts were made by his friends, though none by himself, to dissuade me from persisting in it. But being, as I thought, engaged in the cause of important truth, I proceeded without regard to any consequences, assuring them that this publication should not be injurious to his lordship."

It is not unreasonable to suppose that his lordship, as a keen, practical man of the world, did not derive much satisfaction from this assurance. The "evident marks of dissatisfaction" which Priestley says he first perceived in his patron in 1778, may well have arisen from the peer's not unnatural uneasiness as to what his domesticated, but not tamed, philosopher might write next, and what storm might thereby be brought down on his own head; and it speaks very highly for Lord Shelburne's delicacy that, in the midst of such perplexities, he made not the least attempt to interfere with Priestley's freedom of action. In 1780, however, he intimated to Dr. Price that he should be glad to establish Priestley on his Irish estates: the suggestion was interpreted, as Lord Shelburne probably intended it should be, and Priestley left him, the annuity of £150 a year, which had been promised in view of such a contingency, being punctually paid.

After leaving Calne, Priestley spent some little time in London, and then, having settled in Birmingham at the desire of his brother-in-law, he was soon invited to become the minister of a large congregation. This settlement Priestley considered, at the time, to be "the happiest event of his life." And well he might think so; for it gave him competence and leisure; placed him within reach of the best makers of apparatus of the day; made him a member of that remarkable "Lunar Society," at whose meetings he could exchange thoughts with such men as Watt, Wedgwood, Darwin, and Boulton; and threw open to him the pleasant house of the Galtons of Barr, where these men, and others of less note, formed a society of exceptional charm and intelligence

But these halcyon days were ended by a bitter storm. The French Revolution broke out. An electric shock ran through the

nations; whatever there was of corrupt and retrograde, and, at the same time, a great deal of what there was of best and noblest, in European society shuddered at the outburst of long-pent-up social fires. Men's feelings were excited in a way that we, in this generation, can hardly comprehend. Party wrath and virulence were expressed in a manner unparalleled, and it is to be hoped impossible, in our times; and Priestley and his friends were held up to public scorn, even in Parliament, as fomenters of sedition. A "Church-and-King" cry was raised against the Liberal Dissenters; and, in Birmingham, it was intensified and specially directed towards Priestley by a local controversy, in which he had engaged with his usual vigour. In 1791, the celebration of the second anniversary of the taking of the Bastile by a public dinner, with which Priestley had nothing whatever to do, gave the signal to the loyal and pious mob, who, unchecked, and indeed to some extent encouraged, by those who were responsible for order, had the town at their mercy for three days. The chapels and houses of the leading Dissenters were wrecked, and Priestley and his family had to fly for their lives, leaving library, apparatus, papers, and all their possessions, a prey to the flames.

Priestley never returned to Birmingham. He bore the outrages and losses inflicted upon him with extreme patience and sweetness,* and betook himself to London. But even his scientific colleagues gave him a cold shoulder; and though he was elected minister of a congregation at Hackney, he felt his position to be insecure, and finally determined on emigrating to the United States. He landed in America in 1794; lived quietly with his sons at Northumberland, in Pennsylvania, where his posterity still flourish; and, clear-headed and busy to the last, died on the 6th of February, 1804.

Such were the conditions under which Joseph Priestley did the work which lay before him, and then, as the Norse Sagas say, went out of the story. The work itself was of the most varied kind. No human interest was without its attraction for Priestley, and few men have ever had so many irons in the fire at once; but, though he may have burned his fingers a little, very few who have tried that operation have burned their fingers so little. He made admirable discoveries in science; his philosophical treatises are still well worth reading; his political works are full of in-

* Even Mrs. Priestley, who might be forgiven for regarding the destroyers of her household gods with some asperity, contents herself, in writing to Mrs. Barbauld, with the sarcasm that the Birmingham people "will scarcely find so many respectable characters, a second time, to make a bonfire of."

sight and replete with the spirit of freedom; and while all these sparks flew off from his anvil, the controversial hammer rained a hail of blows on orthodox priest and bishop. While thus engaged, the kindly, cheerful doctor felt no more wrath or uncharitableness towards his opponents than a smith does towards his iron. But if the iron could only speak! — and the priests and bishops took the point of view of the iron.

No doubt what Priestley's friends repeatedly urged upon him — that he would have escaped the heavier trials of his life and won more for the advancement of knowledge, if he had confined himself to his scientific pursuits and let his fellowmen go their way — was true. But it seems to have been Priestley's feeling that he was a man and a citizen before he was a philosopher, and that the duties of the two former positions are at least as imperative as those of the latter. Moreover, there are men (and I think Priestley was one of them) to whom the satisfaction of throwing down a triumphant fallacy is as great as that which attends the discovery of a new truth; who feel better satisfied with the government of the world, when they have been helping Providence by knocking an imposture on the head; and who care even more for freedom of thought than for mere advance of knowledge. These men are the Carnots who organise victory for truth, and they are, at least, as important as the generals who visibly fight her battles in the field.

Priestley's reputation as a man of science rests upon his numerous and important contributions to the chemistry of gaseous bodies; and to form a just estimate of the value of his work — of the extent to which it advanced the knowledge of fact and the development of sound theoretical views — we must reflect what chemistry was in the first half of the eighteenth century.

The vast science which now passes under that name had no existence. Air, water, and fire were still counted among the elemental bodies; and though Van Helmont, a century before, had distinguished different kinds of air as *gas ventosum* and *gas sylvestre,* and Boyle and Hales had experimentally defined the physical properties of air, and discriminated some of the various kinds of aëriform bodies, no one suspected the existence of the numerous totally distinct gaseous elements which are now known, or dreamed that the air we breathe and the water we drink are compounds of gaseous elements.

But, in 1754, a young Scotch physician, Dr. Black, made the first clearing in this tangled backwood of knowledge. And it gives one a wonderful impression of the juvenility of scientific chemistry to think that Lord Brougham, whom so many of us

recollect, attended Black's lectures when he was a student in Edinburgh. Black's researches gave the world the novel and startling conception of a gas that was a permanently elastic fluid like air, but that differed from common air in being much heavier, very poisonous, and in having the properties of an acid, capable of neutralising the strongest alkalies; and it took the world some time to become accustomed to the notion.

A dozen years later, one of the most sagacious and accurate investigators who has adorned this, or any other, country, Henry Cavendish, published a memoir in the "Philosophical Transactions," in which he deals not only with the "fixed air" (now called carbonic acid or carbonic anhydride) of Black, but with "inflammable air," or what we now term hydrogen.

By the rigorous application of weight and measure to all his processes, Cavendish implied the belief subsequently formulated by Lavoisier, that, in chemical processes, matter is neither created nor destroyed, and indicated the path along which all future explorers must travel. Nor did he himself halt until this path led him, in 1784, to the brilliant and fundamental discovery that water is composed of two gases united in fixed and constant proportions.

It is a trying ordeal for any man to be compared with Black and Cavendish, and Priestley cannot be said to stand on their level. Nevertheless his achievements are not only great in themselves, but truly wonderful, if we consider the disadvantages under which he laboured. Without the careful scientific training of Black, without the leisure and appliances secured by the wealth of Cavendish, he scaled the walls of science as so many Englishmen have done before and since his day; and trusting to mother wit to supply the place of training, and to ingenuity to create apparatus out of washing tubs, he discovered more new gases than all his predecessors put together had done. He laid the foundations of gas analysis; he discovered the complementary actions of animal and vegetable life upon the constituents of the atmosphere; and, finally, he crowned his work, this day one hundred years ago, by the discovery of that "pure dephlogisticated air" to which the French chemists subsequently gave the name of oxygen. Its importance, as the constituent of the atmosphere which disappears in the processes of respiration and combustion, and is restored by green plants growing in sunshine, was proved somewhat later. For these brilliant discoveries, the Royal Society elected Priestley a fellow and gave him their medal, while the Academies of Paris and St. Petersburg conferred their membership upon him. Edinburgh had made him an honorary doc-

tor of laws at an early period of his career; but, I need hardly add, that a man of Priestley's opinions received no recognition from the universities of his own country.

That Priestley's contributions to the knowledge of chemical fact were of the greatest importance, and that they richly deserve all the praise that has been awarded to them, is unquestionable; but it must, at the same time, be admitted that he had no comprehension of the deeper significance of his work; and, so far from contributing anything to the theory of the facts which he discovered, or assisting in their rational explanation, his influence to the end of his life was warmly exerted in favour of error. From first to last, he was a stiff adherent of the phlogiston doctrine which was prevalent when his studies commenced; and, by a curious irony of fate, the man who by the discovery of what he called "dephlogisticated air" furnished the essential datum for the true theory of combustion, of respiration, and of the composition of water, to the end of his days fought against the inevitable corollaries from his own labours. His last scientific work, published in 1800, bears the title, "The Doctrine of Phlogiston established, and that of the Composition of Water refuted."

When Priestley commenced his studies, the current belief was, that atmospheric air, freed from accidental impurities, is a simple elementary substance, indestructible and unalterable, as water was supposed to be. When a combustible burned, or when an animal breathed in air, it was supposed that a substance, "phlogiston," the matter of heat and light, passed from the burning or breathing body into it, and destroyed its powers of supporting life and combustion. Thus, air contained in a vessel in which a lighted candle had gone out, or a living animal had breathed until it could breathe no longer, was called "phlogisticated." The same result was supposed to be brought about by the addition of what Priestley called "nitrous gas" to common air.

In the course of his researches, Priestley found that the quantity of common air which can thus become "phlogisticated," amounts to about one-fifth the volume of the whole quantity submitted to experiment. Hence it appeared that common air consists, to the extent of four-fifths of its volume, of air which is already "phlogisticated"; while the other fifth is free from phlogiston, or "dephlogisticated." On the other hand, Priestley found that air "phlogisticated" by combustion or respiration could be "dephlogisticated," or have the properties of pure common air restored to it, by the action of green plants in sunshine. The question, therefore, would naturally arise — as common air can be wholly phlogisticated by combustion, and converted into a substance

which will no longer support combustion, is it possible to get air that shall be less phlogisticated than common air, and consequently support combustion better than common air does?

Now, Priestley says that, in 1774, the possibility of obtaining air less phlogisticated than common air had not occurred to him. But in pursuing his experiments on the evolution of air from various bodies by means of heat, it happened that on the 1st of August, 1774, he threw the heat of the sun, by means of a large burning glass which he had recently obtained, upon a substance which was then called *mercurius calcinatus per se,* and which is commonly known as red precipitate.

"I presently found that, by means of this lens, air was expelled from it very readily. Having got about three or four times as much as the bulk of my materials, I admitted water to it, and found that it was not imbibed by it. But what surprised me more than I can well express, was that a candle burned in this air with a remarkably vigorous flame, very much like that enlarged flame with which a candle burns in nitrous air, exposed to iron or lime of sulphur; but as I had got nothing like this remarkable appearance from any kind of air besides this particular modification of nitrous air, and I knew no nitrous acid was used in the preparation of *mercurius calcinatus*, I was utterly at a loss how to account for it.

"In this case also, though I did not give sufficient attention to the circumstance at that time, the flame of the candle, besides being larger, burned with more splendour and heat than in that species of nitrous air; and a piece of red-hot wood sparkled in it, exactly like paper dipped in a solution of nitre, and it consumed very fast — an experiment which I had never thought of trying with nitrous air."

Priestley obtained the same sort of air from red lead, but, as he says himself, he remained in ignorance of the properties of this new kind of air for seven months, or until March 1775, when he found that the new air behaved with "nitrous gas" in the same way as the dephlogisticated part of common air does; but that, instead of being diminished to four-fifths, it almost completely vanished, and, therefore, showed itself to be "between five and six times as good as the best common air I have ever met with." As this new air thus appeared to be completely free from phlogiston, Priestley called it "dephlogisticated air."

What was the nature of this air? Priestley found that the same kind of air was to be obtained by moistening with the spirit of nitre (which he terms nitrous acid) any kind of earth that is free from phlogiston, and applying heat; and consequently he says: "There remained no doubt on my mind but that the atmospherical air, or the thing that we breathe, consists of the nitrous

acid and earth with so much phlogiston as is necessary to its elasticity, and likewise so much more as is required to bring it from its state of perfect purity to the mean condition in which we find it?"

Priestley's view, in fact, is that atmospheric air is a kind of saltpetre, in which the potash is replaced by some unknown earth. And in speculating on the manner in which saltpetre is formed, he enunciates the hypothesis, "that nitre is formed by a real *decomposition of the air itself*, the *bases* that are presented to it having, in such circumstances, a nearer affinity with the spirit of nitre than that kind of earth with which it is united in the atmosphere."*

It would have been hard for the most ingenious person to have wandered farther from the truth than Priestley does in this hypothesis; and, though Lavoisier undoubtedly treated Priestley very ill, and pretended to have discovered dephlogisticated air, or oxygen, as he called it, independently, we can almost forgive him when we reflect how different were the ideas which the great French chemist attached to the body which Priestley discovered.

They are like two navigators of whom the first sees a new country, but takes clouds for mountains and mirage for lowlands; while the second determines its length and breadth, and lays down on a chart its exact place, so that, thenceforth, it serves as a guide to his successors, and becomes a secure outpost whence new explorations may be pushed.

Nevertheless, as Priestley himself somewhere remarks, the first object of physical science is to ascertain facts, and the service which he rendered to chemistry by the definite establishment of a large number of new and fundamentally important facts, is such as to entitle him to a very high place among the fathers of chemical science.

It is difficult to say whether Priestley's philosophical, political, or theological views were most responsible for the bitter hatred which was borne to him by a large body of his countrymen, and which found its expression in the malignant insinuations in which Burke, to his everlasting shame, indulged in the House of Commons.

Without containing much that will be new to the readers of Hobbs, Spinoza, Collins, Hume, and Hartley, and, indeed, while making no pretensions to originality, Priestley's "Disquisitions relating to Matter and Spirit," and his "Doctrine of Philosophical Necessity Illustrated," are among the most powerful, clear, and un-

* The italics are Priestley's own.

flinching expositions of materialism and necessarianism which exist in the English language, and are still well worth reading.

Priestley denied the freedom of the will in the sense of its self-determination; he denied the existence of a soul distinct from the body; and as a natural consequence, he denied the natural immortality of man.

In relation to these matters English opinion, a century ago, was very much what it is now.

A man may be a necessarian without incurring graver reproach than that implied in being called a gloomy fanatic, necessarianism, though very shocking, having a note of Calvinistic orthodoxy; but, if a man is a materialist; or, if good authorities say he is and must be so, in spite of his assertion to the contrary; or, if he acknowledge himself unable to see good reasons for believing in the natural immortality of man, respectable folks look upon him as an unsafe neighbor of a cashbox, as an actual or potential sensualist, the more virtuous in outward seeming, the more certainly loaded with secret "grave personal sins."

Nevertheless, it is as certain as anything can be, that Joseph Priestley was no gloomy fanatic, but as cheerful and kindly a soul as ever breathed, the idol of children; a man who was hated only by those who did not know him, and who charmed away the bitterest prejudices in personal intercourse; a man who never lost a friend, and the best testimony to whose worth is the generous and tender warmth with which his many friends vied with one another in rendering him substantial help, in all the crises of his career.

The unspotted purity of Priestley's life, the strictness of his performance of every duty, his transparent sincerity, the unostentatious and deep-seated piety which breathes through all his correspondence, are in themselves a sufficient refutation of the hypothesis, invented by bigots to cover uncharitableness, that such opinions as his must arise from moral defects. And his statue will do as good service as the brazen image that was set upon a pole before the Israelites, if those who have been bitten by the fiery serpents of sectarian hatred, which still haunt this wilderness of a world, are made whole by looking upon the image of a heretic who was yet a saint.

Though Priestley did not believe in the natural immortality of man, he held with an almost naïve realism that man would be raised from the dead by a direct exertion of the power of God, and thenceforward be immortal. And it may be as well for those who may be shocked by this doctrine to know that views, substantially identical with Priestley's, have been advocated, since his time, by

two prelates of the Anglican Church: by Dr. Whately, Archbishop of Dublin, in his well-known "Essays"; and by Dr. Courtenay, Bishop of Kingston in Jamaica, the first edition of whose remarkable book "On the Future States," dedicated to Archbishop Whately, was published in 1843 and the second in 1857. According to Bishop Courtenay,

"The death of the body will cause a cessation of all the activity of the mind by way of natural consequence; to continue for ever UNLESS the Creator should interfere."

And again:—

"The natural end of human existence is the 'first death,' the dreamless slumber of the grave, wherein man lies spellbound, soul and body, under the dominion of sin and death — that whatever modes of conscious existence, whatever future state of 'life' or of 'torment' beyond Hades are reserved for man, are results of our blessed Lord's victory over sin and death; that the resurrection of the dead must be preliminary to their entrance into either of the future states, and that the nature and even existence of these states, and even the mere fact that there is a futurity of consciousness, can be known *only* through God's revelation of Himself in the Person and the Gospel of His Son."— P. 389.

And now hear Priestley:—

"Man, according to this system (of materialism), is no more than we now see of him. His being commences at the time of his conception, or perhaps at an earlier period. The corporeal and mental faculties, in being in the same substance, grow, ripen, and decay together; and whenever the system is dissolved, it continues in a state of dissolution till it shall please that Almighty Being who called it into existence to restore it to life again."—"Matter and Spirit," p. 49.

And again:—

"The doctrine of the Scripture is, that God made man of the dust of the ground, and by simply animating this organized matter, made man that living percipient and intelligent being that he is. According to Revelation, *death* is a state of rest and insensibility, and our only though sure hope of a future life is founded on the doctrine of the resurrection of the whole man at some distant period; this assurance being sufficiently confirmed to us both by the evident tokens of a Divine commission attending the persons who delivered the doctrine, and especially by the actual resurrection of Jesus Christ, which is more authentically attested than any other fact in history."—*Ibid.*, p. 247.

We all know that "a saint in crape is twice a saint in lawn;" but it is not yet admitted that the views which are consistent

with such saintliness in lawn, become diabolical when held by a mere dissenter.*

I am not here either to defend or to attack Priestley's philosophical views, and I cannot say that I am personally disposed to attach much value to episcopal authority in philosophical questions; but it seems right to call attention to the fact, that those of Priestley's opinions which have brought most odium upon him have been openly promulgated, without challenge, by persons occupying the highest positions in the State Church.

I must confess that what interests me most about Priestley's materialism, is the evidence that he saw dimly the seed of destruction which such materialism carries within its own bosom. In the course of his reading for his "History of Discoveries relating to Vision, Light, and Colours," he had come upon the speculations of Boscovich and Michell, and had been led to admit the sufficiently obvious truth that our knowledge of matter is a knowledge of its properties: and that of its substance — if it have a substance — we know nothing. And this led to the further admission that, so far as we can know, there may be no difference between the substance of matter and the substance of spirit ("Disquisitions." p. 16). A step farther would have shown Priestley that his materialism was, essentially, very little different from the Idealism of his contemporary, the Bishop of Cloyne.

As Priestley's philosophy is mainly a clear statement of the views of the deeper thinkers of his day, so are his political conceptions based upon those of Locke. Locke's aphorism that "the end of government is the good of mankind," is thus expanded by Priestley:—

"It must necessarily be understood, therefore, whether it be expressed or not, that all people live in society for their mutual advantage; so that the good and happiness of the members, that is, of the majority of the members, of any state, is the great standard by which everything relating to that state must finally be determined."

* Not only is Priestley at one with Bishop Courtenay in this matter, but with Hartley and Bonnet, both of them stout champions of Christianity. Moreover, Archbishop Whately's essay is little better than an expansion of the first paragraph of Hume's famous essay on the Immortality of the Soul:—"By the mere light of reason it seems difficult to prove the immortality of the soul; the arguments for it are commonly derived either from metaphysical topics, or moral, or physical. But it is in reality the Gospel, and the Gospel alone, that has brought *life and immortality to light.*" It is impossible to imagine that a man of Whately's tastes and acquirements had not read Hume or Hartley, though he refers to neither.

The little sentence here interpolated, "that is, of the majority of the members of any state," appears to be that passage which suggested to Bentham, according to his own acknowledgment, the famous "greatest happiness" formula, which by substituting "happiness" for "good," has converted a noble into an ignoble principle. But I do not call to mind that there is any utterance in Locke quite so outspoken as the following passage in the "Essay on the First Principles of Government." After laying down as "a fundamental maxim in all Governments," the proposition that "kings, senators, and nobles" are "the servants of the public," Priestley goes on to say:—

"But in the largest states, if the abuses of the government should at any time be great and manifest; if the servants of the people, forgetting their masters and their masters' interest, should pursue a separate one of their own; if, instead of considering that they are made for the people, they should consider the people as made for them; if the oppressions and violation of right should be great, flagrant, and universally resented; if the tyrannical governors should have no friends but a few sycophants, who had long preyed upon the vitals of their fellow-citizens, and who might be expected to desert a government whenever their interests should be detached from it: if, in consequence of these circumstances, it should become manifest that the risk which would be run in attempting a revolution would be trifling, and the evils which might be apprehended from it were far less than those which were actually suffered and which were daily increasing; in the name of God, I ask, what principles are those which ought to restrain an injured and insulted people from asserting their natural rights, and from changing or even punishing their governors — that is, their servants — who had abused their trust, or from altering the whole form of their government, if it appeared to be of a structure so liable to abuse?"

As a Dissenter, subject to the operation of the Corporation and Test Acts, and as a Unitarian excluded from the benefit of the Toleration Act, it is not surprising to find that Priestley had very definite opinions about Ecclesiastical Establishments; the only wonder is that these opinions were so moderate as the following passages show them to have been:—

"Ecclesiastical authority may have been necessary in the infant state of society, and, for the same reason, it may perhaps continue to be, in some degree, necessary as long as society is imperfect; and therefore may not be entirely abolished till civil governments have arrived at a much greater degree of perfection. If, therefore, I were asked whether I should approve of the immediate dissolution of all the ecclesiastical establishments in Europe, I should answer, No. . . . Let experiment be first made of *alterations*, or, which is the same thing, of *better estab-*

lishments than the present. Let them be reformed in many essential articles, and then not thrown aside entirely till it be found by experience that no good can be made of them."

Priestley goes on to suggest four such reforms of a capital nature:—

"1. Let the Articles of Faith to be subscribed by candidates for the ministry be greatly reduced. In the formulary of the Church of England, might not thirty-eight out of the thirty-nine be very well spared? It is a reproach to any Christian establishment if every man cannot claim the benefit of it who can say that he believes in the religion of Jesus Christ as it is set forth in the New Testament. You say the terms are so general that even Deists would quibble and insinuate themselves. I answer that all the articles which are subscribed at present by no means exclude Deists who will prevaricate; and upon this scheme you would at least exclude fewer honest men."

The second reform suggested is the equalisation, in proportion to work done, of the stipends of the clergy; the third, the exclusion of the Bishops from Parliament; and the fourth, complete toleration, so that every man may enjoy the rights of a citizen, and be qualified to serve his country, whether he belong to the Established Church or not.

Opinions such as those I have quoted, respecting the duties and the responsibilities of governors, are the commonplaces of modern Liberalism; and Priestley's views on Ecclesiastical Establishments would, I fear, meet with but a cool reception, as altogether too conservative, from a large proportion of the lineal descendants of the people who taught their children to cry "Damn Priestley;" and with that love for the practical application of science which is the source of the greatness of Birmingham, tried to set fire to the doctor's house with sparks from his own electrical machine; thereby giving the man they called an incendiary and raiser of sedition against Church and King, an appropriately experimental illustration of the nature of arson and riot.

If I have succeeded in putting before you the main features of Priestley's work, its value will become apparent when we compare the condition of the English nation, as he knew it, with its present state.

The fact that France has been for eighty-five years trying, without much success, to right herself after the great storm of the Revolution, is not unfrequently cited among us as an indication of some inherent incapacity for self-government among the French people. I think, however, that Englishmen who argue



JOSEPH PRIESTLEY.

Engraving of Statue erected in the city of Birmingham, England.

thus, forget that, from the meeting of the Long Parliament in 1640, to the last Stuart rebellion in 1745, is a hundred and five years, and that, in the middle of the last century, we had but just safely freed ourselves from our Bourbons and all that they represented. The corruption of our state was as bad as that of the Second Empire. Bribery was the instrument of government, and peculation its reward. Four-fifths of the seats in the House of Commons were more or less openly dealt with as property. A minister had to consider the state of the vote market, and the sovereign secured a sufficiency of "king's friends" by payments allotted with retail, rather than royal, sagacity.

Barefaced and brutal immorality and intemperance pervaded the land, from the highest to the lowest classes of society. The Established Church was torpid, as far as it was not a scandal; but those who dissented from it came within the meshes of the Act of Uniformity, the Test Act, and the Corporation Act. By law, such a man as Priestley, being a Unitarian, could neither teach nor preach, and was liable to ruinous fines and long imprisonment.* In those days the guns that were pointed by the Church against the Dissenters were shotted. The law was a cesspool of iniquity and cruelty. Adam Smith was a new prophet whom few regarded, and commerce was hampered by idiotic impediments, and ruined by still more absurd help, on the part of government.

Birmingham, though already the centre of a considerable industry, was a mere village as compared with its present extent. People who travelled went about armed, by reason of the abundance of highwaymen and the paucity and inefficiency of the police. Stage coaches had not reached Birmingham, and it took three days to get to London. Even canals were a recent and much opposed invention.

Newton had laid the foundation of a mechanical conception of the physical universe: Hartley, putting a modern face upon ancient materialism, had extended that mechanical conception to psychology; Linnæus and Haller were beginning to introduce method and order into the chaotic accumulation of biological facts. But those parts of physical science which deal with heat, electricity, and magnetism, and above all, chemistry, in the modern sense, can hardly be said to have had an existence. No one knew that two of the old elemental bodies, air and water, are compounds, and that a third, fire, is not a substance but a motion. The great industries that have grown out of the applications of

* In 1732 Doddridge was cited for teaching without the Bishop's leave, at Northampton.

modern scientific discoveries had no existence, and the man who should have foretold their coming into being in the days of his son, would have been regarded as a mad enthusiast.

In common with many other excellent persons, Priestley believed that man is capable of reaching, and will eventually attain, perfection. If the temperature of space presented no obstacle, I should be glad to entertain the same idea; but judging from the past progress of our species, I am afraid that the globe will have cooled down so far, before the advent of this natural millennium, that we shall be, at best, perfected Esquimaux. For all practical purposes, however, it is enough that man may visibly improve his condition in the course of a century or so. And, if the picture of the state of things in Priestley's time, which I have just drawn, have any pretence to accuracy, I think it must be admitted that there has been a considerable change for the better.

I need not advert to the well-worn topic of material advancement, in a place in which the very stones testify to that progress — in the town of Watt and of Boulton. I will only remark, in passing, that material advancement has its share in moral and intellectual progress. Becky Sharp's acute remark that it is not difficult to be virtuous on ten thousand a year, has its application to nations; and it is futile to expect a hungry and squalid population to be anything but violent and gross. But as regards other than material welfare, although perfection is not yet in sight — even from the mast-head — it is surely true that things are much better than they were.

Take the upper and middle classes as a whole, and it may be said that open immorality and gross intemperance have vanished. Four and six bottle men are as extinct as the dodo. Women of good repute do not gamble, and talk modelled upon Dean Swift's "Art of Polite Conversation" would be tolerated in no decent kitchen.

Members of the legislature are not to be bought; and constituents are awakening to the fact that votes must not be sold — even for such trifles as rabbits and tea and cake. Political power has passed into the hands of the masses of the people. Those whom Priestley calls their servants have recognized their position, and have requested the master to be so good as to go to school and fit himself for the administration of his property. In ordinary life, no civil disability attaches to any one on theological grounds, and high offices of the state are open to Papist, Jew, and Secularist.

Whatever men's opinions as to the policy of Establishment, no one can hesitate to admit that the clergy of the Church are men

of pure life and conversation, zealous in the discharge of their duties; and at present, apparently, more bent on prosecuting one another than on meddling with Dissenters. Theology itself has broadened so much, that Anglican divines put forward doctrines more liberal than those of Priestley; and, in our state-supported churches, one listener may hear a sermon to which Bossuet might have given his approbation, while another may hear a discourse in which Socrates would find nothing new.

But great as these changes may be, they sink into insignificance beside the progress of physical science, whether we consider the improvement of methods of investigation, or the increase in bulk of solid knowledge. Consider that the labours of Laplace, of Young, of Davy, and of Faraday; of Cuvier, of Lamarck, and of Robert Brown; of Von Baer, and of Schwann; of Smith and of Hutton, have all been carried on since Priestley discovered oxygen; and consider that they are now things of the past, concealed by the industry of those who have built upon them, as the first founders of a coral reef are hidden beneath the life's work of their successors; consider that the methods of physical science are slowly spreading into all investigations, and that proofs as valid as those required by her canons of investigation are being demanded of all doctrines which ask for men's assent; and you will have a faint image of the astounding difference in this respect between the nineteenth century and the eighteenth.

If we ask what is the deeper meaning of all these vast changes, I think there can be but one reply. They mean that reason has asserted and exercised her primacy over all provinces of human activity; that ecclesiastical authority has been relegated to its proper place; that the good of the governed has been finally recognized as the end of government, and the complete responsibility of governors to the people as its means; and that the dependence of natural phenomena in general on the laws of action of what we call matter has become an axiom.

But it was to bring these things about, and to enforce the recognition of these truths, that Joseph Priestley laboured. If the nineteenth century is other and better than the eighteenth, it is, in great measure, to him, and to such men as he, that we owe the change. If the twentieth century is to be better than the nineteenth, it will be because there are among us men who walk in Priestley's footsteps.

Such men are not those whom their own generation delights to honour; such men, in fact, rarely trouble themselves about honour, but ask, in another spirit than Falstaff's, "What is honour? Who hath it? He that died o' Wednesday." But whether Priest-

ley's lot be theirs, and a future generation, in justice and in gratitude, set up their statues; or whether their names and fame are blotted out from remembrance, their work will live as long as time endures. To all eternity, the sum of truth and right will have been increased by their means; to all eternity, falsehood and injustice will be the weaker because they have lived.

II.

ON THE EDUCATIONAL VALUE OF THE NATURAL HISTORY SCIENCES.

THE subject to which I have to beg your attention during the ensuing hour is "The Relation of Physiological Science to other branches of Knowledge."

Had circumstances permitted of the delivery, in their strict logical order, of that series of discourses of which the present lecture is a member, I should have preceded my friend and colleague Mr. Henfrey, who addressed you on Monday last; but while, for the sake of that order, I must beg you to suppose that this discussion of the Educational bearings of Biology in general *does* precede that of Special Zoology and Botany, I am rejoiced to be able to take advantage of the light thus already thrown upon the tendency and methods of Physiological Science.

Regarding Physiological Science, then, in its widest sense — as the equivalent of *Biology* — the Science of Individual Life — we have to consider in succession:

1. Its position and scope as a branch of knowledge.
2. Its value as a means of mental discipline.
3. Its worth as practical information.

And lastly,

4. At what period it may best be made a branch of Education.

Our conclusions on the first of these heads must depend, of course, upon the nature of the subject-matter of Biology; and I think a few preliminary considerations will place before you in a clear light the vast difference which exists between the living bodies with which Physiological science is concerned, and the remainder of the universe; — between the phænomena of Number and Space, of Physical and of Chemical force, on the one hand, and those of Life on the other.

The mathematician, the physicist, and the chemist contemplate things in a condition of rest; they look upon a state of equilibrium as that to which all bodies normally tend.

The mathematician does not suppose that a quantity will alter, or that a given point in space will change its direction with regard

to another point, spontaneously. And it is the same with the physicist. When Newton saw the apple fall he concluded at once that the act of falling was not the result of any power inherent in the apple, but that it was the result of the action of something else on the apple. In a similar manner, all physical force is regarded as the disturbance of an equilibrium to which things tended before its exertion,— to which they will tend again after its cessation.

The chemist equally regards chemical change in a body as the effect of the action of something external to the body changed. A chemical compound once formed would persist for ever, if no alteration took place in surrounding conditions.

But to the student of Life the aspect of Nature is reversed. Here, incessant, and, so far as we know, spontaneous change is the rule, rest the exception — the anomaly to be accounted for. Living things have no inertia, and tend to no equilibrium.

Permit me, however, to give more force and clearness to these somewhat abstract considerations by an illustration or two.

Imagine a vessel full of water, at the ordinary temperature, in an atmosphere saturated with vapour. The *quantity* and the *figure* of that water will not change, so far as we know, for ever.

Suppose a lump of gold be thrown into the vessel — motion and disturbance of figure exactly proportional to the momentum of the gold will take place. But after a time the effects of this disturbance will subside — equilibrium will be restored, and the water will return to its passive state.

Expose the water to cold — it will solidify — and in so doing its particles will arrange themselves in definite crystalline shapes. But once formed, these crystals change no further.

Again, substitute for the lump of gold some substance capable of entering into chemical relations with the water:— say, a mass of that substance which is called "protein" — the substance of flesh: — a very considerable disturbance of equilibrium will take place — all sorts of chemical compositions and decompositions will occur; but in the end, as before, the result will be the resumption of a condition of rest.

Instead of such a mass of *dead* protein, however, take a particle of *living* protein — one of those minute microscopic living things which throng our pools, and are known as Infusoria — such a creature, for instance, as an Euglena, and place it in our vessel of water. It is a round mass provided with a long filament, and except in this peculiarity of shape, presents no appreciable physical or chemical difference whereby it might be distinguished from the particle of dead protein.

But the difference in the phænomena to which it will give rise is immense: in the first place it will develop a vast quantity of physical force — cleaving the water in all directions with considerable rapidity by means of the vibrations of the long filament of cilium.

Nor is the amount of chemical energy which the little creature possesses less striking. It is a perfect laboratory in itself, and it will act and react upon the water and the matters contained therein; converting them into new compounds resembling its own substance, and at the same time giving up portions of its own substance which have become effete.

Furthermore, the Euglena will increase in size; but this increase is by no means unlimited, as the increase of a crystal might be. After it has grown to a certain extent it divides, and each portion assumes the form of the original, and proceeds to repeat the process of growth and division.

Nor is this all. For after a series of such divisions and subdivisions, these minute points assume a totally new form, lose their long tails — round themselves, and secrete a sort of envelope or box, in which they remain shut up for a time, eventually to resume, directly or indirectly, their primitive mode of existence.

Now, so far as we know, there is no natural limit to the existence of the Euglena, or of any other living germ. A living species once launched into existence tends to live for ever.

Consider how widely different this living particle is from the dead atoms with which the physicist and chemist have to do!

The particle of gold falls to the bottom and rests — the particle of dead protein decomposes and disappears — it also rests: but the *living* protein mass neither tends to exhaustion of its forces nor to any permanency of form, but is essentially distinguished as a disturber of equilibrium so far as force is concerned,—as undergoing continual metamorphosis and change, in point of form.

Tendency to equilibrium of force and to permanency of form, then, are the characters of that portion of the universe which does not live — the domain of the chemist and physicist.

Tendency to disturb existing equilibrium — to take on forms which succeed one another in definite cycles — is the character of the living world.

What is the cause of this wonderful difference between the dead particle and the living particle of matter appearing in other respects identical? that difference to which we give the name of Life?

I, for one, cannot tell you. It may be that, by and by, philosophers will discover some higher laws of which the facts of life are

particular cases — very possibly they will find out some bond between physico-chemical phænomena on the one hand, and vital phænomena on the other. At present, however, we assuredly know of none; and I think we shall exercise a wise humility in confessing that, for us at least, this successive assumption of different states —(external conditions remaining the same)— this *spontaneity of action* — If I may use the term which implies more than I would be answerable for — which constitutes so vast and plain a practical distinction between living bodies and those which do not live, is an ultimate fact; indicating as such, the existence of a broad line of demarcation between the subject-matter of Biological and that of all other sciences.

For I would have it understood that this simple Euglena is the type of *all* living things, so far as the distinction between these and inert matter is concerned. That cycle of changes, which is constituted by perhaps not more than two or three steps in the Euglena, is as clearly manifested in the multitudinous stages through which the germ of an oak or of a man passes. Whatever forms the Living Being may take on, whether simple or complex, *production, growth, reproduction,* are the phænomena which distinguish it from that which does not live.

If this be true, it is clear that the student, in passing from the physico-chemical to the physiological sciences, enters upon a totally new order of facts; and it will next be for us to consider how far these new facts involve *new* methods, or require a modification of those with which he is already acquainted. Now a great deal is said about the peculiarity of the scientific method in general, and of the different methods which are pursued in the different sciences. The Mathematics are said to have one special method; Physics another, Biology a third, and so forth. For my own part, I must confess that I do not understand this phraseology.

So far as I can arrive at any clear comprehension of the matter, Science is not, as many would seem to suppose, a modification of the black art, suited to the tastes of the nineteenth century, and flourishing mainly in consequence of the decay of the Inquisition.

Science is, I believe, nothing but *trained and organised common sense,* differing from the latter only as a veteran may differ from a raw recruit: and its methods differ from those of common sense only so far as the guardsman's cut and thrust differ from the manner in which a savage wields his club. The primary power is the same in each case, and perhaps the untutored savage has the more brawny arm of the two. The *real* advantage lies in the point and polish of the swordsman's weapon; in the trained

eye quick to spy out the weakness of the adversary; in the ready hand prompt to follow it on the instant. But, after all, the sword exercise is only the hewing and poking of the clubman developed and perfected.

So, the vast results obtained by Science are won by no mystical faculties, by no mental processes, other than those which are practised by every one of us, in the humblest and meanest affairs of life. A detective policeman discovers a burglar from the marks made by his shoe, by a mental process identical with that by which Cuvier restored the extinct animals of Montmartre from fragments of their bones. Nor does that process of induction and deduction by which a lady, finding a stain of a peculiar kind upon her dress, concludes that somebody has upset the inkstand thereon, differ in any way, in kind, from that by which Adams and Leverrier discovered a new planet.

The man of science, in fact, simply uses with scrupulous exactness the methods which we all, habitually and at every moment, use carelessly; and the man of business must as much avail himself of the scientific method — must be as truly a man of science — as the veriest bookworm of us all; though I have no doubt that the man of business will find himself out to be a philosopher with as much surprise as M. Jourdain exhibited when he discovered that he had been all his life talking prose. If, however, there be no real difference between the methods of science and those of common life, it would seem, on the face of the matter, highly improbable that there should be any difference between the methods of the different sciences; nevertheless, it is constantly taken for granted that there is a very wide difference between the Physiological and other sciences in point of method.

In the first place it is said — and I take this point first, because the imputation is too frequently admitted by Physiologists themselves — that Biology differs from the Physico-chemical and Mathematical sciences in being "inexact."

Now, this phrase "inexact" must refer either to the *methods* or to the *results* of Physiological science.

It cannot be correct to apply it to the methods; for, as I hope to show you by and by, these are identical in all sciences, and whatever is true of Physiological method is true of Physical and Mathematical method.

Is it then the *results* of Biological science which are "inexact"? I think not. If I say that respiration is performed by the lungs; that digestion is effected in the stomach; that the eye is the organ of sight; that the jaws of a vertebrated animal never open sideways, but always up and down; while those of an annulose animal

always open sideways, and never up and down — I am enumerating propositions which are as exact as anything in Euclid. How then has this notion of the inexactness of Biological science come about? I believe from two causes: first, because in consequence of the great complexity of the science and the multitude of interfering conditions, we are very often only enabled to predict approximately what will occur under given circumstances; and secondly, because, on account of the comparative youth of the Physiological sciences, a great many of their laws are still imperfectly worked out. But, in an educational point of view, it is most important to distinguish between the essence of a science and the accidents which surround it; and essentially, the methods and results of Physiology are as exact as those of Physics or Mathematics.

It is said that the Physiological method is especially *comparative**; and this dictum also finds favour in the eyes of many. I should be sorry to suggest that the speculators on scientific classification have been misled by the accident of the name of one leading branch of Biology — *Comparative Anatomy;* but I would ask whether *comparison,* and that classification which is the result of comparison, are not the essence of every science whatsoever? How is it possible to discover a relation of cause and effect of *any* kind without comparing a series of cases together in which the supposed cause and effect occur singly, or combined? So far from comparison being in any way peculiar to Biological science, it is, I think, the essence of every science.

A speculative philosopher again tells us that the Biological sciences are distinguished by being sciences of observation and not of experiment! †

* "In the third place, we have to review the method of Comparison, which is so specially adapted to the study of living bodies, and by which, above all others, that study must be advanced. In Astronomy, this method is necessarily inapplicable; and it is not till we arrive at Chemistry that this third means of investigation can be used; and then only in subordination to the two others. It is in the study, both statical and dynamical, of living bodies that it first acquires its full development; and its use elsewhere can be only through its application here."— COMTE'S *Positive Philosophy,* translated by Miss Martineau. Vol. i. p. 372.

By what method does M. Comte suppose that the equality or inequality of forces and quantities and the dissimilarity or similarity of forms — points of some slight importance not only in Astronomy and Physics, but even in Mathematics — are ascertained, if not by Comparison?

† "Proceeding to the second class of means.— Experiment cannot but be less and less decisive, in proportion to the complexity of the phænomena to be explored; and therefore we saw this resource to be less effectual in chemistry than in physics: and we now find that it is eminently useful in chemistry in comparison with physiology. *In fact, the nature of the phœnomena seems to offer almost insurmountable im-*

Of all the strange assertions into which speculation without practical acquaintance with a subject may lead even an able man, I think this is the very strangest. Physiology not an experimental science? Why, there is not a function of a single organ in the body which has not been determined wholly and solely by experiment? How did Harvey determine the nature of the circulation, except by experiment? How did Sir Charles Bell determine the functions of the roots of the spinal nerve, save by experiment? How do we know the use of a nerve at all, except by experiment? Nay, how do we know even that your eye is your seeing apparatus, unless you make the experiment of shutting it or that your ear is your hearing apparatus, unless you close it up and thereby discover that you become deaf?

It would really be much more true to say that Physiology is *the* experimental science *par excellence* of all sciences; that in which there is least to be learnt by mere observation, and that which affords the greatest field for the exercise of those faculties which characterise the experimental philosopher. I confess, if any one were to ask me for a model application of the logic of experiment, I should know no better work to put into his hands than Bernard's late Researches on the Functions of the Liver.*

Not to give this lecture a too controversial tone, however, I must only advert to one more doctrine, held by a thinker of our own age and country, whose opinions are worthy of all respect. It is, that the Biological sciences differ from all others, inasmuch as in *them* classification takes place by type and not by definition.†

It is said, in short, that a natural-history class is not capable of being defined — that the class Rosaceæ, for instance, or the

pediments to any extensive and prolific application of such a procedure in biology."— COMTE, vol. i. p. 367.

M. Comte, as his manner is, contradicts himself two pages further on, but that will hardly relieve him from the responsibility of such a paragraph as the above.

* *Nouvelle Fonction du Foie considéré comme organe producteur de matière sucrée chez l'Homme et les Animaux, par* M. Claude Bernard.

† "*Natural Groups given by Type, not by Definition.* The class is steadily fixed, though not precisely limited; it is given, though not circumscribed; it is determined, not by a boundary-line without, but by a central point within; not by what it strictly excludes, but what it eminently includes; by an example, not by a precept; in short, instead of Definition we have a *Type* for our director. A type is an example of any class, for instance, a species of a genus, which is considered as eminently possessing the characters of the class. All the species which have a greater affinity with this type-species than with any others, form the genus, and are ranged about it, deviating from it in various directions and different degrees."— WHEWELL, *The Philosophy of the Inductive Sciences*, vol. i. pp. 476, 477.

class of Fishes, is not accurately and absolutely definable, inasmuch as its members will present exceptions to every possible definition and that the members of the class are united together only by the circumstance that they are all more like some imaginary average rose or average fish, than they resemble anything else.

But here, as before, I think the distinction has arisen entirely from confusing a transitory imperfection with an essential character. So long as our information concerning them is imperfect, we class all objects together according to resemblances which we *feel,* but cannot define; we group them round *types,* in short. Thus if you ask an ordinary person what kinds of animals there are, he will probably say, beasts, birds, reptiles, fishes, insects, &c. Ask him to define a beast from a reptile, and he cannot do it; but he says, things like a cow or a horse are beasts, and things like a frog or a lizard are reptiles. You see *he does* class by type, and not by definition. But how does this classification differ from that of a scientific Zoologist? How does the meaning of the scientific class-name of "Mammalia" differ from the unscientific of "Beasts"?

Why, exactly because the former depends on a definition, the latter on a type. The class Mammalia is scientifically defined as "all animals which have a vertebrated skeleton and suckle their young." Here is no reference to type, but a definition rigorous enough for a geometrician. And such is the character which every scientific naturalist recognizes as that to which his classes must aspire — knowing, as he does, that classification by type is simply an acknowledgment of ignorance and a temporary device.

So much in the way of negative argument as against the reputed differences between Biological and other methods. No such differences, I believe, really exist. The subject-matter of Biological science is different from that of other sciences, but the methods of all are identical; and these methods are —

1. *Observation* of facts — including under this head that *artificial observation* which is called *experiment.*

2. That process of tying up similar facts into bundles ticketed and ready for use, which is called *Comparison* and *Classification,* — the results of the process, the ticketed bundles, being named *General propositions.*

3. *Deduction,* which takes us from the general proposition to facts again — teaches us, if I may so say, to anticipate from the ticket what is inside the bundle. And finally —

4. *Verification,* which is the process of ascertaining whether, in point of fact, our anticipation is a correct one.

Such are the methods of all science whatsoever; but perhaps you will permit me to give you an illustration of their employment in the science of Life; and I will take as a special case the establishment of the doctrine of the *Circulation of the Blood.*

In this case, *simple observation* yields us a knowledge of the existence of the blood from some accidental hæmorrhage, we will say; we may even grant that it informs us of the localisation of this blood in particular vessels, the heart, &c., from some accidental cut or the like. It teaches also the existence of a pulse in various parts of the body, and acquaints us with the structure of the heart and vessels.

Here, however, *simple observation* stops, and we must have recourse to *experiment.*

You tie a vein, and you find that the blood accumulates on the side of the ligature opposite the heart. You tie an artery, and you find that the blood accumulates on the side near the heart. Open the chest, and you see the heart contracting with great force. Make openings into its principal cavities, and you will find that all the blood flows out, and no more pressure is exerted on either side of the arterial or venous ligature.

Now all these facts, taken together, constitute the evidence that the blood is propelled by the heart through the arteries, and returns by the veins — that, in short, the blood circulates.

Suppose our experiments and observations have been made on horses, then we group and ticket them into a general proposition, thus: — *all horses have a circulation of their blood.*

Henceforward a horse is a sort of indication or label, telling us where we shall find a peculiar series of phænomena called the circulation of the blood.

Here is our *general proposition,* then.

How, and when, are we justified in making our next step — a *deduction* from it?

Suppose our physiologist, whose experience is limited to horses, meets with a zebra for the first time,— will he suppose that this generalisation holds good for zebras also?

That depends very much on his turn of mind. But we will suppose him to be a bold man. He will say, "The zebra is certainly not a horse, but it is very like one,— so like, that it must be the 'ticket' or mark of a blood-circulation also; and I conclude that the zebra has a circulation."

That is a deduction, a very fair deduction, but by no means to be considered scientifically secure. This last quality in fact can only be given by *verification* — that is, by making a zebra

the subject of all the experiments performed on the horse. Of course, in the present case, the *deduction* would be *confirmed* by this process of verification, and the result would be, not merely a positive widening of knowledge, but a fair increase of confidence in the truth of one's generalisations in other cases.

Thus, having settled the point in the zebra and horse, our philosopher would have great confidence in the existence of a circulation in the ass. Nay, I fancy most persons would excuse him, if in this case he did not take the trouble to go through the process of verification at all; and it would not be without a parallel in the history of the human mind, if our imaginary physiologist now maintained that he was acquainted with asinine circulation *à priori*.

However, if I might impress any caution upon your minds, it is, the utterly conditional nature of all our knowledge,— the danger of neglecting the process of verification under any circumstances; and the film upon which we rest, the moment our deductions carry us beyond the reach of this great process of verification. There is no better instance of this than is afforded by the history of our knowledge of the circulation of the blood in the animal kingdom until the year 1824. In every animal possessing a circulation at all, which had been observed up to that time, the current of the blood was known to take one definite and invariable direction. Now, there is a class of animals called *Ascidians*, which possess a heart and a circulation, and up to the period of which I speak, no one would have dreamt of questioning the propriety of the deduction, that these creatures have a circulation in one direction; nor would any one have thought it worth while to verify the point. But, in that year, M. von Hasselt, happening to examine a transparent animal of this class, found, to his infinite surprise, that after the heart had beat a certain number of times, it stopped, and then began beating the opposite way — so as to reverse the course of the current, which returned by and by to its original direction.

I have myself timed the heart of these little animals. I found it as regular as possible in its periods of reversal: and I know no spectacle in the animal kingdom more wonderful than that which it presents — all the more wonderful that to this day it remains an unique fact, peculiar to this class among the whole animated world. At the same time I know of no more striking case of the necessity of the *verification* of even those deductions which seem founded on the widest and safest inductions.

Such are the methods of Biology — methods which are obviously identical with those of all other sciences, and therefore wholly

incompetent to form the ground of any distinction between it and them.*

But I shall be asked at once, Do you mean to say that there is no difference between the habit of mind of a mathematician and that of a naturalist? Do you imagine that Laplace might have been put into the Jardin des Plantes, and Cuvier into the Observatory, with equal advantage to the progress of the sciences they professed?

To which I would reply, that nothing could be further from my thoughts. But different habits and various special tendencies of two sciences do not imply different methods. The mountaineer and the man of the plains have very different habits of progression, and each would be at a loss in the other's place; but the method of progression, by putting one leg before the other, is the same in each case. Every step of each is a combination of a lift and a push; but the mountaineer lifts more and the lowlander pushes more. And I think the case of two sciences resembles this.

I do not question for a moment, that while the Mathematician is busy with deductions *from* general propositions, the Biologist is more especially occupied with observation, comparison, and those processes which lead *to* general propositions. All I wish to insist upon is, that this difference depends not on any fundamental distinction in the sciences themselves, but on the accidents of their subject-matter, of their relative complexity, and consequent relative perfection.

The Mathematician deals with two properties of objects only, number and extension, and all the inductions he wants have been formed and finished ages ago. He is occupied now with nothing but deduction and verification.

The Biologist deals with a vast number of properties of objects, and his inductions will not be completed, I fear, for ages to come; but when they are, his science will be as deductive and as exact as the Mathematics themselves.

Such is the relation of Biology to those sciences which deal with objects having fewer properties than itself. But as the student, in reaching Biology, looks back upon sciences of a less complex and therefore more perfect nature; so, on the other hand, does he look forward to other more complex and less perfect branches of knowledge. Biology deals only with living beings as isolated things — treats only of the life of the individual: but

* Save for the pleasure of doing so, I need hardly point out my obligations to Mr. J. S. Mill's *System of Logic*, in this view of scientific method.

there is a higher division of science still, which considers living beings as aggregates — which deals with the relation of living beings one to another — the science which *observes* men — whose *experiments* are made by nations one upon another, in battle-fields — whose *general propositions* are embodied in history, morality, and religion — whose *deductions* lead to our happiness or our misery — and whose *verifications* so often come too late, and serve only

"To point a moral, or adorn a tale"—

I mean the science of Society or *Sociology*.

I think it is one of the grandest features of Biology, that it occupies this central position in human knowledge. There is no side of the human mind which physiological study leaves uncultivated. Connected by innumerable ties with abstract science, Physiology is yet in the most intimate relation with humanity; and by teaching us that law and order, and a definite scheme of development, regulate even the strangest and wildest manifestations of individual life, she prepares the student to look for a goal even amidst the erratic wanderings of mankind, and to believe that history offers something more than an entertaining chaos — a journal of a toilsome, tragi-comic march nowither.

The preceding considerations have, I hope, served to indicate the replies which befit the first two of the questions which I set before you at starting, viz. What is the range and position of Physiological Science as a branch of knowledge, and what is its value as a means of mental discipline?

Its *subject-matter* is a large moiety of the universe — its *position* is midway between the physico-chemical and the social sciences. Its *value* as a branch of discipline is partly that which it has in common with all sciences — the training and strengthening of common sense; partly that which is more peculiar to itself — the great exercise which it affords to the faculties of observation and comparison; and, I may add, the *exactness* of knowledge which it requires on the part of those among its votaries who desire to extend its boundaries.

If what has been said as to the position and scope of Biology be correct, our third question — What is the practical value of physiological instruction? — might, one would think, be left to answer itself.

On other grounds even, were mankind deserving of the title "rational," which they arrogate to themselves, there can be no question that they would consider, as the most necessary of all branches of instruction for themselves and for their children, that

which professes to acquaint them with the conditions of the existence they prize so highly — which teaches them how to avoid disease and to cherish health, in themselves and those who are dear to them.

I am addressing, I imagine, an audience of educated persons; and yet I dare venture to assert that, with the exception of those of my hearers who may chance to have received a medical education, there is not one who could tell me what is the meaning and use of an act which he performs a score of times every minute, and whose suspension would involve his immediate death; — I mean the act of breathing — or who could state in precise terms why it is that a confined atmosphere is injurious to health.

The *practical value* of Physiological knowledge! Why is it that educated men can be found to maintain that a slaughter-house in the midst of a great city is rather a good thing than otherwise? — that mothers persist in exposing the largest possible amount of surface of their children to the cold, by the absurd style of dress they adopt, and then marvel at the peculiar dispensation of Providence, which removes their infants by bronchitis and gastric fever? Why is it that quackery rides rampant over the land; and that not long ago, one of the largest public rooms in this great city could be filled by an audience gravely listening to the reverend expositor of the doctrine — that the simple physiological phænomena known as spirit-rapping, table-turning, phreno-magnetism, and I know not what other absurd and inappropriate names, are due to the direct and personal agency of Satan?

Why is all this, except from the utter ignorance as to the simplest laws of their own animal life, which prevails among even the most highly educated persons in this country?

But there are other branches of Biological Science, besides Physiology proper, whose practical influence, though less obvious, is not, as I believe, less certain. I have heard educated men speak with an ill-disguised contempt of the studies of the naturalist, and ask, not without a shrug, "What is the use of knowing all about these miserable animals — what bearing has it on human life?"

I will endeavour to answer that question. I take it that all will admit there is definite Government of this universe — that its pleasures and pains are not scattered at random, but are distributed in accordance with orderly and fixed laws, and that it is only in accordance with all we know of the rest of the world, that there should be an agreement between one portion of the sensitive creation and another in these matters.

Surely then it interests us to know the lot of other animal

creatures — however far below us, they are still the sole created things which share with us the capability of pleasure and the susceptibility to pain.

I cannot but think that he who finds a certain proportion of pain and evil inseparably woven up in the life of the very worms, will bear his own share with more courage and submission; and will, at any rate, view with suspicion those weakly amiable theories of the Divine government, which would have us believe pain to be an oversight and a mistake,— to be corrected by and by. On the other hand, the predominance of happiness among living things — their lavish beauty — the secret and wonderful harmony which pervades them all, from the highest to the lowest, are equally striking refutations of that modern Manichean doctrine, which exhibits the world as a slave-mill, worked with many tears, for mere utilitarian ends.

There is yet another way in which natural history may, I am convinced, take a profound hold upon practical life,— and that is, by its influence over our finer feelings, as the greatest of all sources of that pleasure which is derivable from beauty. I do not pretend that natural-history knowledge, as such, can increase our sense of the beautiful in natural objects. I do not suppose that the dead soul of Peter Bell, of whom the great poet of nature says,—

> A primrose by the river's brim,
> A yellow primrose was to him,—
> And it was nothing more,—

would have been a whit roused from its apathy by the information that the primrose is a Dicotyledonous Exogen, with a monopetalous corolla and central placentation. But I advocate natural-history knowledge from this point of view, because it would lead us to *seek* the beauties of natural objects, instead of trusting to chance to force them on our attention. To a person uninstructed in natural history, his country or sea-side stroll is a walk through a gallery filled with wonderful works of art, nine-tenths of which have their faces turned to the wall. Teach him something of natural history, and you place in his hands a catalogue of those which are worth turning round. Surely our innocent pleasures are not so abundant in this life, that we can afford to despise this or any other source of them. We should fear being banished for our neglect to that limbo, where the great Florentine tells us are those who, during this life, "wept when they might be joyful."

But I shall be trespassing unwarrantably on your kindness, if I

do not proceed at once to my last point — the time at which Physiological Science should first form a part of the Curriculum of Education.

The distinction between the teaching of the facts of a science as instruction, and the teaching it systematically as knowledge, has already been placed before you in a previous lecture: and it appears to me that, as with other sciences, the *common facts* of Biology — the uses of parts of the body — the names and habits of the living creatures which surround us — may be taught with advantage to the youngest child. Indeed, the avidity of children for this kind of knowledge, and the comparative ease with which they retain it, is something quite marvellous. I doubt whether any toy would be so acceptable to young children as a vivarium of the same kind as, but of course on a smaller scale than, those admirable devices in the Zoological Gardens.

On the other hand, systematic teaching in Biology cannot be attempted with success until the student has attained to a certain knowledge of physics and chemistry: for though the phænomena of life are dependent neither on physical nor on chemical, but on vital forces, yet they result in all sorts of physical and chemical changes, which can only be judged by their own laws.

And now to sum up in a few words the conclusions to which I hope you see reason to follow me.

Biology needs no apologist when she demands a place — and a prominent place — in any scheme of education worthy of the name. Leave out the Physiological sciences from your curriculum, and you launch the student into the world, undisciplined in that science whose subject-matter would best develop his powers of observation; ignorant of facts of the deepest importance for his own and others' welfare; blind to the richest sources of beauty in God's creation; and unprovided with that belief in a living law, and an order manifesting itself in and through endless change and variety, which might serve to check and moderate that phase of despair through which, if he take an earnest interest in social problems, he will assuredly sooner or later pass.

Finally, one word for myself. I have not hesitated to speak strongly where I have felt strongly; and I am but too conscious that the indicative and imperative moods have too often taken the place of the more becoming subjunctive and conditional. I feel, therefore, how necessary it is to beg you to forget the personality of him who has thus ventured to address you, and to consider only the truth or error in what has been said.

III.

EMANCIPATION—BLACK AND WHITE.

QUASHIE'S plaintive inquiry, "Am I not a man and a brother?" seems at last to have received its final reply—the recent decision of the fierce trial by battle on the other side of the Atlantic fully concurring with that long since delivered here in a more peaceful way.

The question is settled; but even those who are most thoroughly convinced that the doom is just, must see good grounds for repudiating half the arguments which have been employed by the winning side; and for doubting whether its ultimate results will embody the hopes of the victors, though they may more than realise the fears of the vanquished. It may be quite true that some negroes are better than some white men; but no rational man, cognisant of the facts, believes that the average negro is the equal, still less the superior, of the average white man. And, if this be true, it is simply incredible that, when all his disabilities are removed, and our prognathous relative has a fair field and no favour, as well as no oppressor, he will be able to compete successfully with his bigger-brained and smaller-jawed rival, in a contest which is to be carried on by thoughts and not by bites. The highest places in the hierarchy of civilisation will assuredly not be within the reach of our dusky cousins, though it is by no means necessary that they should be restricted to the lowest. But whatever the position of stable equilibrium into which the laws of social gravitation may bring the negro, all responsibility for the result will henceforward lie between Nature and him. The white man may wash his hands of it, and the Caucasian conscience be void of reproach for evermore. And this, if we look to the bottom of the matter, is the real justification for the abolition policy.

The doctrine of equal natural rights may be an illogical delusion; emancipation may convert the slave from a well-fed animal into a pauperised man; mankind may even have to do without cotton shirts; but all these evils must be faced if the moral law, that no human being can arbitrarily dominate over another with-

out grievous damage to his own nature, be, as many think, as readily demonstrable by experiment as any physical truth. If this be true, no slavery can be abolished without a double emancipation, and the master will benefit by freedom more than the freedman.

The like considerations apply to all the other questions of emancipation which are at present stirring the world — the multifarious demands that classes of mankind shall be relieved from restrictions imposed by the artifice of man, and not by the necessities of Nature. One of the most important, if not the most important, of all these, is that which daily threatens to become the "irrepressible" woman question. What social and political rights have women? What ought they to be allowed, or not allowed, to do, be, and suffer? And as involved in, and underlying all these questions, how ought they to be educated?

There are philogynists as fanatical as any "misogynists" who, reversing our antiquated notions, bid the man look upon the woman as the higher type of humanity; who ask us to regard the female intellect as the clearer and the quicker, if not the stronger; who desire us to look up to the feminine moral sense as the purer and the nobler; and bid man abdicate his usurped sovereignty over Nature in favour of the female line. On the other hand, there are persons not to be outdone in all loyalty and just respect for womankind, but by nature hard of head and haters of delusion, however charming, who not only repudiate the new woman-worship which so many sentimentalists and some philosophers are desirous of setting up, but, carrying their audacity further, deny even the natural equality of the sexes. They assert, on the contrary, that in every excellent character, whether mental or physical, the average woman is inferior to the average man, in the sense of having that character less in quantity and lower in quality. Tell these persons of the rapid perceptions and the instinctive intellectual insight of women, and they reply that the feminine mental peculiarities, which pass under these names, are merely the outcome of a greater impressibility to the superficial aspects of things, and of the absence of that restraint upon expression which, in men, is imposed by reflection and a sense of responsibility. Talk of the passive endurance of the weaker sex, and opponents of this kind remind you that Job was a man, and that, until quite recent times, patience and long-suffering were not counted among the specially feminine virtues. Claim passionate tenderness as especially feminine, and the inquiry is made whether all the best love-poetry in existence (except, perhaps, the "Sonnets from the Portuguese") has not been written by men; whether the song

which embodies the ideal of pure and tender passion — "Adelaida" — was written by *Frau* Beethoven; whether it was the Fornarina, or Raphael, who painted the Sistine Madonna. Nay, we have known one such heretic go so far as to lay his hands upon the ark itself, so to speak, and to defend the startling paradox that, even in physical beauty, man is the superior. He admitted, indeed, that there was a brief period of early youth when it might be hard to say whether the prize should be awarded to the graceful undulations of the female figure, or the perfect balance and supple vigour of the male frame. But while our new Paris might hesitate between the youthful Bacchus and the Venus emerging from the foam, he averred that, when Venus and Bacchus had reached thirty, the point no longer admitted of a doubt; the male form having then attained its greatest nobility, while the female is far gone in decadence; and that, at this epoch, womanly beauty, so far as it is independent of grace or expression, is a question of drapery and accessories.

Supposing, however, that all these arguments have a certain foundation; admitting, for a moment, that they are comparable to those by which the inferiority of the negro to the white man may be demonstrated, are they of any value as against woman-emancipation? Do they afford us the smallest ground for refusing to educate women as well as men — to give women the same civil and political rights as men? No mistake is so commonly made by clever people as that of assuming a cause to be bad because the arguments of its supporters are, to a great extent, nonsensical. And we conceive that those who may laugh at the arguments of the extreme philogynists, may yet feel bound to work heart and soul towards the attainment of their practical ends.

As regards education, for example. Granting the alleged defects of women, is it not somewhat absurd to sanction and maintain a system of education which would seem to have been specially contrived to exaggerate all these defects?

Naturally not so firmly strung, nor so well balanced as boys, girls are in great measure debarred from the sports and physical exercises which are justly thought absolutely necessary for the full development of the vigour of the more favoured sex. Women are, by nature, more excitable than men — prone to be swept by tides of emotion, proceeding from hidden and inward, as well as from obvious and external causes; and female education does its best to weaken every physical counterpoise to this nervous mobility — tends in all ways to stimulate the emotional part of the mind and stunt the rest. We find girls naturally timid, inclined

to dependence, born conservatives; and we teach them that independence is unladylike; that blind faith is the right frame of mind; and that whatever we may be permitted, and indeed encouraged, to do to our brother, our sister is to be left to the tyranny of authority and tradition. With few insignificant exceptions, girls have been educated either to be drudges, or toys, beneath man; or a sort of angels above him; the highest ideal aimed at oscillating between Clärchen and Beatrice. The possibility that the ideal of womanhood lies neither in the fair saint, nor in the fair sinner; that the female type of character is neither better nor worse than the male, but only weaker; that women are meant neither to be men's guides nor their playthings, but their comrades, their fellows, and their equals, so far as Nature puts no bar to that equality, does not seem to have entered into the minds of those who have had the conduct of the education of girls.

If the present system of female education stands self-condemned, as inherently absurd; and if that which we have just indicated is the true position of woman, what is the first step towards a better state of things? We reply, emancipate girls. Recognise the fact that they share the senses, perceptions, feelings, reasoning powers, emotions of boys, and that the mind of the average girl is less different from that of the average boy, than the mind of one boy is from that of another; so that whatever argument justifies a given education for all boys, justifies its application to girls as well. So far from imposing artificial restrictions upon the acquirement of knowledge by women, throw every facility in their way. Let our Faustinas, if they will, toil through the whole round of

> "Juristerei und Medizin,
> Und leider! auch Philosophie."

Let us have "sweet girl graduates" by all means. They will be none the less sweet for a little wisdom; and the "golden hair" will not curl less gracefully outside the head by reason of there being brains within. Nay, if obvious practical difficulties can be overcome, let those women who feel inclined to do so descend into the gladiatorial arena of life, not merely in the guise of *retiariæ*, as heretofore, but as bold *sicariæ*, breasting the open fray. Let them, if they so please, become merchants, barristers, politicians. Let them have a fair field, but let them understand, as the necessary correlative, that they are to have no favour. Let Nature alone sit high above the lists, "rain influence and judge the prize."

And the result? For our parts, though loth to prophesy, we believe it will be that of other emancipations. Women will find

their place, and it will neither be that in which they have been held, nor that to which some of them aspire. Nature's old salique law will not be repealed, and no change of dynasty will be affected. The big chests, the massive brains, the vigorous muscles and stout frames of the best men will carry the day, whenever it is worth their while to contest the prizes of life with the best women. And the hardship of it is that the very improvement of the women will lessen their chances. Better mothers will bring forth better sons, and the impetus gained by the one sex will be transmitted, in the next generation, to the other. The most Darwinian of theorists will not venture to propound the doctrine, that the physical disabilities under which women have hitherto laboured in the struggle for existence with men are likely to be removed by even the most skilfully conducted process of educational selection.

We are, indeed, fully prepared to believe that the bearing of children may, and ought to, become as free from danger and long disability to the civilised woman as it is to the savage; nor is it improbable that, as society advances towards its right organisation, motherhood will occupy a less space of woman's life than it has hitherto done. But still, unless the human species is to come to an end altogether — a consummation which can hardly be desired by even the most ardent advocate of "women's rights" — somebody must be good enough to take the trouble and responsibility of annually adding to the world exactly as many people as die out of it. In consequence of some domestic difficulties, Sydney Smith is said to have suggested that it would have been good for the human race had the model offered by the hive been followed, and had all the working part of the female community been neuters. Failing any thorough-going reform of this kind, we see nothing for it but the old division of humanity into men potentially, or actually, fathers, and women potentially, if not actually, mothers. And we fear that so long as this potential motherhood is her lot, woman will be found to be fearfully weighted in the race of life.

The duty of man is to see that not a grain is piled upon that load beyond what Nature imposes; that injustice is not added to inequality.

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IV.

A LIBERAL EDUCATION; AND WHERE TO FIND IT.

THE business which the South London Working Men's College has undertaken is a great work; indeed, I might say, that Education, with which that college proposes to grapple, is the greatest work of all those which lie ready to a man's hand just at present.

And, at length, this fact is becoming generally recognised. You cannot go anywhere without hearing a buzz of more or less confused and contradictory talk on this subject — nor can you fail to notice that, in one point at any rate, there is a very decided advance upon like discussions in former days. Nobody outside the agricultural interest now dares to say that education is a bad thing. If any representative of the once large and powerful party, which, in former days, proclaimed this opinion, still exists in the semi-fossil state, he keeps his thoughts to himself. In fact, there is a chorus of voices, almost distressing in their harmony, raised in favour of the doctrine that education is the great panacea for human troubles, and that, if the country is not shortly to go to the dogs, everybody must be educated.

The politicians tell us, "You must educate the masses because they are going to be masters." The clergy join in the cry for education, for they affirm that the people are drifting away from church and chapel into the broadest infidelity. The manufacturers and the capitalists swell the chorus lustily. They declare that ignorance makes bad workmen; that England will soon be unable to turn out cotton goods, or steam engines, cheaper than other people; and then, Ichabod! Ichabod! the glory will be departed from us. And a few voices are lifted up in favour of the doctrine that the masses should be educated because they are men and women with unlimited capacities of being, doing, and suffering, and that it is as true now, as it ever was, that the people perish for lack of knowledge.

These members of the minority, with whom I confess I have a good deal of sympathy, are doubtful whether any of the other reasons urged in favour of the education of the people are of much

value — whether, indeed, some of them are based upon either wise or noble grounds of action. They question if it be wise to tell people that you will do for them, out of fear of their power, what you have left undone, so long as your only motive was compassion for their weakness and their sorrows. And, if ignorance of everything which it is needful a ruler should know is likely to do so much harm in the governing classes of the future, why is it, they ask reasonably enough, that such ignorance in the governing classes of the past has not been viewed with equal horror?

Compare the average artisan and the average country squire, and it may be doubted if you will find a pin to choose between the two in point of ignorance, class feeling, or prejudice. It is true that the ignorance is of a different sort — that the class feeling is in favour of a different class — and that the prejudice has a distinct savour of wrongheadedness in each case — but it is questionable if the one is either a bit better, or a bit worse, than the other. The old protectionist theory is the doctrine of trades unions as applied by the squires, and the modern trades unionism is the doctrine of the squires applied by the artisans. Why should we be worse off under one *régime* than under the other?

Again, this sceptical minority asks the clergy to think whether it is really want of education which keeps the masses away from their ministrations — whether the most completely educated men are not as open to reproach on this score as the workmen; and whether, perchance, this may not indicate that it is not education which lies at the bottom of the matter?

Once more, these people, whom there is no pleasing, venture to doubt whether the glory which rests upon being able to undersell all the rest of the world, is a very safe kind of glory — whether we may not purchase it too dear; especially if we allow education, which ought to be directed to the making of men, to be diverted into a process of manufacturing human tools, wonderfully adroit in the exercise of some technical industry, but good for nothing else.

And, finally, these people inquire whether it is the masses alone who need a reformed and improved education. They ask whether the richest of our public schools might not well be made to supply knowledge, as well as gentlemanly habits, a strong class feeling, and eminent proficiency in cricket. They seem to think that the noble foundations of our old universities are hardly fulfilling their functions in their present posture of half-clerical seminaries, half racecourses, where men are trained to win a senior wrangleship, or a double-first, as horses are trained to win a cup, with as little reference to the needs of after-life in the case of a man as in that

of the racer. And, while as zealous for education as the rest, they affirm that, if the education of the richer classes were such as to fit them to be the leaders and the governors of the poorer; and, if the education of the poorer classes were such as to enable them to appreciate really wise guidance and good governance, the politicians need not fear mob-law, nor clergy lament their want of flocks, nor the capitalists prognosticate the annihilation of the prosperity of the country.

Such is the diversity of opinion upon the why and the wherefore of education. And my hearers will be prepared to expect that the practical recommendations which are put forward are not less discordant. There is a loud cry for compulsory education. We English, in spite of constant experience to the contrary, preserve a touching faith in the efficacy of acts of Parliament; and I believe we should have compulsory education in the course of next session, if there were the least probability that half a dozen leading statesmen of different parties would agree what that education should be.

Some hold that education without theology is worse than none. Others maintain, quite as strongly, that education with theology is in the same predicament. But this is certain, that those who hold the first opinion can by no means agree what theology should be taught; and that those who maintain the second are in a small minority.

At any rate "make people learn to read, write, and cipher," say a great many; and the advice is undoubtedly sensible as far as it goes. But, as has happened to me in former days, those who, in despair of getting anything better, advocate this measure, are met with the objection that it is very like making a child practise the use of a knife, fork, and spoon, without giving it a particle of meat. I really don't know what reply is to be made to such an objection.

But it would be unprofitable to spend more time in disentangling, or rather in showing up the knots in, the ravelled skeins of our neighbours. Much more to the purpose is it to ask if we possess any clue of our own which may guide us among these entanglements. And by way of a beginning, let us ask ourselves — What is education? Above all things, what is our ideal of a thoroughly liberal education? — of that education which, if we could begin life again, we would give ourselves — of that education which, if we could mould the fates to our own will, we would give our children? Well, I know not what may be your conceptions upon this matter, but I will tell you mine, and I hope I shall find that our views are not very discrepant.

Suppose it were perfectly certain that the life and fortune of every one of us would, one day or other, depend upon his winning or losing a game of chess. Don't you think that we should all consider it to be a primary duty to learn at least the names and moves of the pieces; to have a notion of a gambit, and a keen eye for all the means of giving and getting out of check? Do you not think that we should look with a disapprobation amounting to scorn, upon the father who allowed his son, or the state which allowed its members, to grow up without knowing a pawn from a knight?

Yet it is a very plain and elementary truth, that the life, the fortune, and the happiness of every one of us, and more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess-board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of Nature. The player on the other side is hidden from us. We know that his play is always fair, just and patient. But also we know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well, the highest stakes are paid, with that sort of overflowing generosity with which the strong shows delight in strength. And one who plays ill is checkmated — without haste, but without remorse.

My metaphor will remind some of you of the famous picture in which Retzsch has depicted Satan playing at chess with man for his soul. Substitute for the mocking fiend in that picture a calm, strong angel who is playing for love, as we say, and would rather lose than win — and I should accept it as an image of human life.

Well, what I mean by Education is learning the rules of this mighty game. In other words, education is the instruction of the intellect in the laws of Nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. For me, education means neither more nor less than this. Anything which professes to call itself education must be tried by this standard, and if it fails to stand the test, I will not call it education, whatever may be the force of authority, or of numbers, upon the other side.

It is important to remember that, in strictness, there is no such

thing as an uneducated man. Take an extreme case. Suppose that an adult man, in the full vigour of his faculties, could be suddenly placed in the world, as Adam is said to have been, and then left to do as he best might. How long would he be left uneducated? Not five minutes. Nature would begin to teach him, through the eye, the ear, the touch, the properties of objects. Pain and pleasure would be at his elbow telling him to do this and avoid that; and by slow degrees the man would receive an education which, if narrow, would be thorough, real, and adequate to his circumstances, though there would be no extras and very few accomplishments.

And if to this solitary man entered a second Adam, or, better still, an Eve, a new and greater world, that of social and moral phenomena, would be revealed. Joys and woes, compared with which all others might seem but faint shadows, would spring from the new relations. Happiness and sorrow would take the place of the coarser monitors, pleasure and pain; but conduct would still be shaped by the observation of the natural consequences of actions; or, in other words, by the laws of the nature of man.

To every one of us the world was once as fresh and new as to Adam. And then, long before we were susceptible of any other modes of instruction, Nature took us in hand, and every minute of waking life brought its educational influence, shaping our actions into rough accordance with Nature's laws, so that we might not be ended untimely by too gross disobedience. Nor should I speak of this process of education as past for any one, be he as old as he may. For every man the world is as fresh as it was at the first day, and as full of untold novelties for him who has the eyes to see them. And Nature is still continuing her patient education of us in that great university, the universe, of which we are all members — Nature having no Test-Acts.

Those who take honours in Nature's university, who learn the laws which govern men and things and obey them, are the really great and successful men in this world. The great mass of mankind are the "Poll," who pick up just enough to get through without much discredit. Those who won't learn at all are plucked; and then you can't come up again. Nature's pluck means extermination.

Thus the question of compulsory education is settled so far as Nature is concerned. Her bill on that question was framed and passed long ago. But, like all compulsory legislation, that of Nature is harsh and wasteful in its operation. Ignorance is visited as sharply as wilful disobedience — incapacity meets with the same punishment as crime. Nature's discipline is not even a word

and a blow, and the blow first; but the blow without the word. It is left to you to find out why your ears are boxed.

The object of what we commonly call education — that education in which man intervenes and which I shall distinguish as artificial education — is to make good these defects in Nature's methods; to prepare the child to receive Nature's education, neither incapably nor ignorantly, nor with wilful disobedience; and to understand the preliminary symptoms of her pleasure, without waiting for the box on the ear. In short, all artificial education ought to be an anticipation of natural education. And a liberal education is an artificial education which has not only prepared a man to escape the great evils of disobedience to natural laws, but has trained him to appreciate and to seize upon the rewards, which Nature scatters with as free a hand as her penalties.

That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of Nature or of art, to hate all vileness, and to respect others as himself.

Such an one and no other, I conceive, has had a liberal education; for he is, as completely as a man can be, in harmony with Nature. He will make the best of her, and she of him. They will get on together rarely; she as his ever beneficent mother; he as her mouthpiece, her conscious self, her minister and interpreter.

Where is such an education as this to be had? Where is there any approximation to it? Has any one tried to found such an education? Looking over the length and breadth of these islands, I am afraid that all these questions must receive a negative answer. Consider our primary schools and what is taught in them. A child learns —

1. To read, write, and cipher, more or less well; but in a very large proportion of cases not so well as to take pleasure in reading, or to be able to write the commonest letter properly.

2. A quantity of dogmatic theology, of which the child, nine times out of ten, understands next to nothing.

3. Mixed up with this, so as to seem to stand or fall with it, a

few of the broadest and simplest principles of morality. This, to my mind, is much as if a man of science should make the story of the fall of the apple in Newton's garden an integral part of the doctrine of gravitation, and teach it as of equal authority with the law of the inverse squares.

4. A good deal of Jewish history and Syrian geography, and perhaps a little something about English history and the geography of a child's own country. But I doubt if there is a primary school in England in which hangs a map of the hundred in which the village lies, so that the children may be practically taught by it what a map means.

5. A certain amount of regularity, attentive obedience, respect for others: obtained by fear, if the master be incompetent or foolish; by love and reverence, if he be wise.

So far as this school course embraces a training in the theory and practice of obedience to the moral laws of Nature, I gladly admit, not only that it contains a valuable educational element, but that, so far, it deals with the most valuable and important part of all education. Yet, contrast what is done in this direction with what might be done; with the time given to matters of comparatively no importance; with the absence of any attention to things of the highest moment; and one is tempted to think of Falstaff's bill and "the halfpenny worth of bread to all that quantity of sack."

Let us consider what a child thus "educated" knows, and what it does not know. Begin with the most important topic of all—morality, as the guide of conduct. The child knows well enough that some acts meet with approbation and some with disapprobation. But it has never heard that there lies in the nature of things a reason for every moral law, as cogent and as well defined as that which underlies every physical law; that stealing and lying are just as certain to be followed by evil consequences, as putting your hand in the fire, or jumping out of a garret window. Again, though the scholar may have been made acquainted, in dogmatic fashion, with the broad laws of morality, he has had no training in the application of those laws to the difficult problems which result from the complex conditions of modern civilisation. Would it not be very hard to expect any one to solve a problem in conic sections who had merely been taught the axioms and definitions of mathematical science?

A workman has to bear hard labour, and perhaps privation, while he sees others rolling in wealth, and feeding their dogs with what would keep his children from starvation. Would it not be well to have helped that man to calm the natural promptings

of discontent by showing him, in his youth, the necessary connection of the moral law which prohibits stealing with the stability of society — by proving to him, once for all, that it is better for his own people, better for himself, better for future generations, that he should starve than steal? If you have no foundation of knowledge, or habit of thought, to work upon, what chance have you of persuading a hungry man that a capitalist is not a thief "with a circumbendibus?" And if he honestly believes that, of what avail is it to quote the commandment against stealing, when he proposes to make the capitalist disgorge?

Again, the child learns absolutely nothing of the history or the political organisation of his own country. His general impression is, that everything of much importance happened a very long while ago; and that the Queen and the gentlefolks govern the country much after the fashion of King David and the elders and nobles of Israel — his sole models. Will you give a man with this much information a vote? In easy times he sells it for a pot of beer. Why should he not? It is of about as much use to him as a chignon, and he knows as much what to do with it, for any other purpose. In bad times, on the contrary, he applies his simple theory of government, and believes that his rulers are the cause of his sufferings — a belief which sometimes bears remarkable practical fruits.

Least of all, does the child gather from this primary "education" of ours a conception of the laws of the physical world, or of the relations of cause and effect therein. And this is the more to be lamented, as the poor are especially exposed to physical evils, and are more interested in removing them than any other class of the community. If any one is concerned in knowing the ordinary laws of mechanics one would think it is the hand-labourer, whose daily toil lies among levers and pulleys; or among the other implements of artisan work. And if any one is interested in the laws of health, it is the poor workman, whose strength is wasted by ill-prepared food, whose health is sapped by bad ventilation and bad drainage, and half whose children are massacred by disorders which might be prevented. Not only does our present primary education carefully abstain from hinting to the workman that some of his greatest evils are traceable to mere physical agencies, which could be removed by energy, patience, and frugality; but it does worse — it renders him, so far as it can, deaf to those who could help him, and tries to substitute an Oriental submission to what is falsely declared to be the will of God, for his natural tendency to strive after a better condition.

What wonder, then, if very recently an appeal has been made

to statistics for the profoundly foolish purpose of showing that education is of no good — that it diminishes neither misery nor crime among the masses of mankind? I reply, why should the thing which has been called education do either the one or the other? If I am a knave or a fool, teaching me to read and write won't make me less of either one or the other — unless somebody shows me how to put my reading and writing to wise and good purposes.

Suppose any one were to argue that medicine is of no use, because it could be proved statistically, that the percentage of deaths was just the same among people who had been taught how to open a medicine chest, and among those who did not so much as know the key by sight. The argument is absurd; but it is not more preposterous than that against which I am contending. The only medicine for suffering, crime, and all the other woes of mankind, is wisdom. Teach a man to read and write, and you have put into his hands the great keys of the wisdom box. But it is quite another matter whether he ever opens the box or not. And he is as likely to poison as to cure himself, if, without guidance, he swallows the first drug that comes to hand. In these times a man may as well be purblind, as unable to read — lame, as unable to write. But I protest that, if I thought the alternative were a necessary one, I would rather that the children of the poor should grow up ignorant of both these mighty arts, than that they should remain ignorant of that knowledge to which these arts are means.

It may be said that all these animadversions may apply to primary schools, but that the higher schools, at any rate, must be allowed to give a liberal education. In fact they professedly sacrifice everything else to this object.

Let us inquire into this matter. What do the higher schools, those to which the great middle class of the country sends its children, teach, over and above the instruction given in the primary schools? There is a little more reading and writing of English. But, for all that, every one knows that it is a rare thing to find a boy of the middle or upper classes who can read aloud decently, or who can put his thoughts on paper in clear and grammatical (to say nothing of good or elegant) language. The "ciphering" of the lower schools expands into elementary mathematics in the higher; into arithmetic, with a little algebra, a little Euclid. But I doubt if one boy in five hundred has ever heard the explanation of a rule of arithmetic, or knows his Euclid otherwise than by rote.

Of theology, the middle class schoolboy gets rather less than poorer children, less absolutely and less relatively, because there are so many other claims upon his attention. I venture to say that, in the great majority of cases, his ideas on this subject when he leaves school are of the most shadowy and vague description, and associated with painful impressions of the weary hours spent in learning collects and catechism by heart.

Modern geography, modern history, modern literature; the English language as a language; the whole circle of the sciences, physical, moral and social, are even more completely ignored in the higher than in the lower schools. Up till within a few years back, a boy might have passed through any one of the great public schools with the greatest distinction and credit, and might never so much as have heard of one of the subjects I have just mentioned. He might never have heard that the earth goes round the sun; that England underwent a great revolution in 1688, and France another in 1789; that there once lived certain notable men called Chaucer, Shakespeare, Milton, Voltaire, Goethe, Schiller. The first might be a German and the last an Englishman for anything he could tell you to the contrary. And as for science, the only idea the word would suggest to his mind would be dexterity in boxing.

I have said that this was the state of things a few years back, for the sake of the few righteous who are to be found among the educational cities of the plain. But I would not have you too sanguine about the result, if you sound the minds of the existing generation of public schoolboys, on such topics as those I have mentioned.

Now let us pause to consider this wonderful state of affairs; for the time will come when Englishmen will quote it as the stock example of the stolid stupidity of their ancestors in the nineteenth century. The most thoroughly commercial people, the greatest voluntary wanderers and colonists the world has ever seen, are precisely the middle class of this country. If there be a people which has been busy making history on the great scale for the last three hundred years — and the most profoundly interesting history — history which, if it happened to be that of Greece or Rome, we should study with avidity — it is the English. If there be a people which, during the same period, has developed a remarkable literature, it is our own. If there be a nation whose prosperity depends absolutely and wholly upon their mastery over the forces of Nature, upon their intelligent apprehension of, and obedience to the laws of the creation and distribution of wealth, and of the stable equilibrium of the forces of society, it is precisely this

nation. And yet this is what these wonderful people tell their sons:—"At the cost of from one to two thousand pounds of our hard-earned money, we devote twelve of the most precious years of your lives to school. There you shall toil, or be supposed to toil; but there you shall not learn one single thing of all those you will most want to know directly you leave school and enter upon the practical business of life. You will in all probability go into business, but you shall not know where, or how, any article of commerce is produced, or the difference between export or an import, or the meaning of the word 'capital.' You will very likely settle in a colony, but you shall not know whether Tasmania is part of New South Wales, or *vice versâ*.

"Very probably you may become a manufacturer, but you shall not be provided with the means of understanding the working of one of your own steam-engines, or the nature of the raw products you employ; and, when you are asked to buy a patent, you shall not have the slightest means of judging whether the inventor is an impostor who is contravening the elementary principles of science, or a man who will make you as rich as Crœsus.

"You will very likely get into the House of Commons. You will have to take your share in making laws which may prove a blessing or a curse to millions of men. But you shall not hear one word respecting the political organisation of your country; the meaning of the controversy between free-traders and protectionists shall never have been mentioned to you; you shall not so much as know that there are such things as economical laws.

"The mental power which will be of most importance in your daily life will be the power of seeing things as they are without regard to authority; and of drawing accurate general conclusions from particular facts. But at school and at college you shall know of no source of truth but authority; nor exercise your reasoning faculty upon anything but deduction from that which is land down by authority.

"You will have to weary your soul with work, and many a time eat your bread in sorrow and in bitterness, and you shall not have learned to take refuge in the great source of pleasure without alloy, the serene resting place for worn human nature,— the world of art."

Said I not rightly that we are a wonderful people? I am quite prepared to allow, that education entirely devoted to these omitted subjects might not be a completely liberal education. But is an education which ignores them all a liberal education? Nay, is it too much to say that the education which should embrace these subjects and no others would be a real education, though an in-

complete one; while an education which omits them is really not an education at all, but a more or less useful course of intellectual gymnastics?

For what does the middle-class school put in the place of all these things which are left out? It substitutes what is usually comprised under the compendious title of the "classics"—that is to say, the languages, the literature, and the history of the ancient Greeks and Romans, and the geography of so much of the world as was known to these two great nations of antiquity. Now, do not expect me to depreciate the earnest and enlightened pursuit of classical learning. I have not the least desire to speak ill of such occupations, nor any sympathy with them who run them down. On the contrary, if my opportunities had lain in that direction, there is no investigation into which I could have thrown myself with greater delight than that of antiquity.

What science can present greater attractions than philology? How can a lover of literary excellence fail to rejoice in the ancient masterpieces? And with what consistency could I, whose business lies so much in the attempt to decipher the past, and to build up intelligible forms out of the scattered fragments of long extinct beings, fail to take a sympathetic, though an unlearned, interest in the labours of a Niebuhr, a Gibbon, or a Grote? Classical history is a great section of the palæontology of man; and I have the same double respect for it as for other kinds of palæontology—that is to say, a respect for the facts which it establishes as for all facts, and a still greater respect for it as a preparation for the discovery of a law of progress.

But if the classics were taught as they might be taught—if boys and girls were instructed in Greek and Latin, not merely as languages, but as illustrations of philological science; if a vivid picture of life on the shores of the Mediterranean two thousand years ago were imprinted on the minds of scholars; if ancient history were taught, not as a weary series of feuds and fights, but traced to its causes in such men placed under such conditions; if, lastly, the study of the classical books were followed in such a manner as to impress boys with their beauties, and with the grand simplicity of their statement of the everlasting problems of human life, instead of with their verbal and grammatical peculiarities; I still think it as little proper that they should form the basis of a liberal education for our contemporaries, as I should think it fitting to make that sort of palæontology with which I am familiar the back-bone of modern education.

It is wonderful how close a parallel to classical training could be made out of that palæontology to which I refer. In the first

place I could get up an osteological primer so arid, so pedantic in its terminology, so altogether distasteful to the youthful mind, as to beat the recent famous production of the head-masters out of the field in all these excellences. Next, I could exercise my boys upon easy fossils, and bring out all their powers of memory and all their ingenuity in the application of my osteo-grammatical rules to the interpretation, or construing, of those fragments. To those who had reached the higher classes, I might supply odd bones to be built up into animals, giving great honour and reward to him who succeeded in fabricating monsters most entirely in accordance with the rules. That would answer to verse-making and essay-writing in the dead languages.

To be sure, if a great comparative anatomist were to look at these fabrications he might shake his head, or laugh. But what then? Would such a catastrophe destroy the parallel? What, think you, would Cicero, or Horace, say to the production of the best sixth form going? And would not Terence stop his ears and run out if he could be present at an English performance of his own plays? Would *Hamlet,* in the mouths of a set of French actors, who should insist on pronouncing English after the fashion of their own tongue, be more hideously ridiculous?

But it will be said that I am forgetting the beauty, and the human interest, which appertain to classical studies. To this I reply that it is only a very strong man who can appreciate the charms of a landscape as he is toiling up a steep hill, along a bad road. What with short-windedness, stones, ruts, and a pervading sense of the wisdom of rest and be thankful, most of us have little enough sense of the beautiful under these circumstances. The ordinary schoolboy is precisely in this case. He finds Parnassus uncommonly steep, and there is no chance of his having much time or inclination to look about him till he gets to the top. And nine times out of ten he does not get to the top.

But if this be a fair picture of the results of classical teaching at its best — and I gather from those who have authority to speak on such matters that it is so — what is to be said of classical teaching at its worst, or in other words, of the classics of our ordinary middle-class schools?* I will tell you. It means getting up endless forms and rules by heart. It means turning Latin and Greek into English, for the mere sake of being able to do it, and without the smallest regard to the worth, or worthlessness, of the author read. It means the learning of innumerable, not always decent, fables in such a shape that the meaning they

* For a justification of what is here said about these schools, see that valuable book, *Essays on a Liberal Education, passim.*

once had is dried up into other trash; and the only impression left upon a boy's mind is, that the people who believed such things must have been the greatest idiots the world ever saw. And it means, finally, that after a dozen years spent at this kind of work, the sufferer shall be incompetent to interpret a passage in an author he has not already got up; that he shall loathe the sight of a Greek or Latin book; and that he shall never open, or think of, a classical writer again, until, wonderful to relate, he insists upon submitting his sons to the same process.

These be your gods, O Israel! For the sake of this net result (and respectability) the British father denies his children all the knowledge they might turn to account in life, not merely for the achievement of vulgar success, but for guidance in the great crises of human existence. This is the stone he offers to those whom he is bound by the strongest and tenderest ties to feed with bread.

If primary and secondary education are in this unsatisfactory state, what is to be said to the universities? This is an awful subject, and one I almost fear to touch with my unhallowed hands; but I can tell you what those say who have authority to speak.

The Rector of Lincoln College, in his lately published valuable "Suggestions for Academical Organisation with especial reference to Oxford," tells us (p. 127):—

"The colleges were, in their origin, endowments, not for the elements of a general liberal education, but for the prolonged study of special and professional faculties by men of riper age. The universities embraced both these objects. The colleges, while they incidentally aided in elementary education, were specially devoted to the highest learning . . .

"This was the theory of the middle-age university and the design of collegiate foundations in their origin. Time and circumstances have brought about a total change. The colleges no longer promote the researches of science, or direct professional study. Here and there college walls may shelter an occasional student, but not in larger proportions than may be found in private life. Elementary teaching of youths under twenty is now the only function performed by the university, and almost the only object of college endowments. Colleges were homes for the life-study of the highest and most abstruse parts of knowledge. They have become boarding schools in which the elements of the learned languages are taught to youths."

If Mr. Pattison's high position, and his obvious love and re-

spect for his university, be insufficient to convince the outside world that language so severe is yet no more than just, the authority of the Commissioners who reported on the University of Oxford in 1850 is open to no challenge. Yet they write:—

"It is generally acknowledged that both Oxford and the country at large suffer greatly from the absence of a body of learned men devoting their lives to the cultivation of science, and to the direction of academical education.

"The fact that so few books of profound research emanate from the University of Oxford, materially impairs its character as a seat of learning, and consequently its hold on the respect of the nation."

Cambridge can claim no exemption from the reproaches addressed to Oxford. And thus there seems no escape from the admission that what we fondly call our great seats of learning are simply "boarding schools" for bigger boys; that learned men are not more numerous in them than out of them; that the advancement of knowledge is not the object of fellows of colleges; that, in the philosophic calm and meditative stillness of their greenswarded courts, philosophy does not thrive, and meditation bears few fruits.

It is my great good fortune to reckon amongst my friends resident members of both universities, who are men of learning and research, zealous cultivators of science, keeping before their minds a noble ideal of a university, and doing their best to make that ideal a reality; and, to me, they would necessarily typify the universities, did not the authoritative statements I have quoted compel me to believe that they are exceptional, and not representative men. Indeed, upon calm consideration, several circumstances lead me to think that the Rector of Lincoln College and the Commissioners cannot be far wrong.

I believe there can be no doubt that the foreigner who should wish to become acquainted with the scientific, or the literary, activity of modern England, would simply lose his time and his pains if he visited our universities with that object.

And, as for works of profound research on any subject, and, above all, in that classical lore for which the universities profess to sacrifice almost everything else, why, a third-rate, poverty-stricken German university turns out more produce of that kind in one year, than our vast and wealthy foundations elaborate in ten.

Ask the man who is investigating any question, profoundly and thoroughly — be it historical, philosophical, philological, physical, literary, or theological; who is trying to make himself master of

any abstract subject (except, perhaps, political economy and geology, both of which are intensely Anglican sciences), whether he is not compelled to read half a dozen times as many German as English books? And whether, of these English books, more than one in ten is the work of a fellow of a college, or a professor of an English university?

Is this from any lack of power in the English as compared with the German mind? The countrymen of Grote and of Mill, of Faraday, of Robert Brown, of Lyell, and of Darwin, to go no further back than the contemporaries of men of middle age, can afford to smile at such a suggestion. England can show now, as she has been able to show in every generation since civilisation spread over the West, individual men who hold their own against the world, and keep alive the old tradition of their intellectual eminence.

But, in the majority of cases, these men are what they are in virtue of their native intellectual force, and of a strength of character which will not recognise impediments. They are not trained in the courts of the Temple of Science, but storm the walls of that edifice in all sorts of irregular ways, and with much loss of time and power, in order to obtain their legitimate positions.

Our universities not only do not encourage such men; do not offer them positions, in which it should be their highest duty to do, thoroughly, that which they are most capable of doing; but, as far as possible, university training shuts out of the minds of those among them, who are subjected to it, the prospect that there is anything in the world for which they are specially fitted. Imagine the success of the attempt to still the intellectual hunger of any of the men I have mentioned, by putting before him, as the object of existence, the successful mimicry of the measure of a Greek song, or the roll of Ciceronian prose! Imagine how much success would be likely to attend the attempt to persuade such men that the education which leads to perfection in such elegances is alone to be called culture; while the facts of history, the process of thought, the conditions of moral and social existence, and the laws of physical nature are left to be dealt with as they may by outside barbarians!

It is not thus that the German universities, from being beneath notice a century ago, have become what they are now — the most intensely cultivated and the most productive intellectual corporations the world has ever seen.

The student who repairs to them sees in the list of classes and of professors a fair picture of the world of knowledge. What-

ever he needs to know there is some one ready to teach him, some one competent to discipline him in the way of learning; whatever his special bent, let him but be able and diligent, and in due time he shall find distinction and a career. Among his professors, he sees men whose names are known and revered throughout the civilised world; and their living example infects him with a noble ambition, and a love for the spirit of work.

The Germans dominate the intellectual world by virtue of the same simple secret as that which made Napoleon the master of old Europe. They have declared *la carrière ouverte aux talents,* and every Bursch marches with a professor's gown in his knapsack. Let him become a great scholar, or man of science, and ministers will compete for his services. In Germany, they do not leave the chance of his holding the office he would render illustrious to the tender mercies of a hot canvass, and the final wisdom of a mob of country parsons.

In short, in Germany, the universities are exactly what the Rector of Lincoln and the Commissioners tell us the English universities are not; that is to say, corporations "of learned men devoting their lives to the cultivation of science, and the direction of academical education." They are not "boarding schools for youths," nor clerical seminaries; but institutions for the higher culture of men, in which the theological faculty is of no more importance or prominence, than the rest; and which are truly "universities," since they strive to represent and embody the totality of human knowledge, and to find room for all forms of intellectual activity.

May zealous and clear-headed reformers like Mr. Pattison succeed in their noble endeavors to shape our universities towards some such ideal as this, without losing what is valuable and distinctive in their social tone! But until they have succeeded, a liberal education will be no more obtainable in our Oxford and Cambridge Universities than in our public schools.

If I am justified in my conception of the ideal of a liberal education; and if what I have said about the existing educational institutions of the country is also true, it is clear that the two have no sort of relation to one another; that the best of our schools and the most complete of our university trainings give but a narrow, one-sided, and essentially illiberal education — while the worst give what is really next to no education at all. The South London Working-Men's College could not copy any of these institutions if it would; I am bold enough to express the conviction that it ought not if it could.

For what is wanted is the reality and not the mere name of a

liberal education; and this College must steadily set before itself the ambition to be able to give that education sooner or later. At present we are but beginning, sharpening our educational tools, as it were, and, except a modicum of physical science, we are not able to offer much more than is to be found in an ordinary school.

Moral and social science — one of the greatest and most fruitful of our future classes, I hope — at present lacks only one thing in our programme, and that is a teacher. A considerable want, no doubt; but it must be recollected that it is much better to want a teacher than to want the desire to learn.

Further, we need what, for want of a better name, I must call Physical Geography. What I mean is that which the Germans call "*Erdkunde.*" It is a description of the earth, of its place and relation to other bodies; of its general structure, and of its great features — winds, tides, mountains, plains: of the chief forms of the vegetable and animal worlds, of the varieties of man. It is the peg upon which the greatest quantity of useful and entertaining scientific information can be suspended.

Literature is not upon the College programme; but I hope some day to see it there. For literature is the greatest of all sources of refined pleasure, and one of the great uses of a liberal education is to enable us to enjoy that pleasure. There is scope enough for the purposes of liberal education in the study of the rich treasures of our own language alone. All that is needed is direction and the cultivation of a refined taste by attention to sound criticism. But there is no reason why French and German should not be mastered sufficiently to read what is worth reading in those languages with pleasure and with profit.

And finally, by and by, we must have History; treated not as a succession of battles and dynasties; not as a series of biographies; not as evidence that Providence has always been on the side of either Whigs or Tories; but as the development of man in times past, and in other conditions than our own.

But, as it is one of the principles of our College to be self-supporting, the public must lead, and we must follow, in these matters. If my hearers take to heart what I have said about liberal education, they will desire these things, and I doubt not we shall be able to supply them. But we must wait till the demand is made.

V.

SCIENTIFIC EDUCATION: NOTES OF AN AFTER-DINNER SPEECH.

[MR. THACKERAY, talking of after-dinner speeches, has lamented that "one never can recollect the fine things one thought of in the cab," in going to the place of entertainment. I am not aware that there are any "fine things" in the following pages, but such as there are stand to a speech which really did get itself spoken, at the hospitable table of the Liverpool Philomathic Society, more or less in the position of what "one thought of in the cab."]

THE introduction of scientific training into the general education of the country is a topic upon which I could not have spoken, without some more or less apologetic introduction, a few years ago. But upon this, as upon other matters, public opinion has of late undergone a rapid modification. Committees of both Houses of the Legislature have agreed that something must be done in this direction, and have even thrown out timid and faltering suggestions as to what should be done; while at the opposite pole of society, committees of working men have expressed their conviction that scientific training is the one thing needful for their advancement, whether as men, or as workmen. Only the other day, it was my duty to take part in the reception of a deputation of London workingmen, who desired to learn from Sir Roderick Murchison, the Director of the Royal School of Mines, whether the organisation of the institution in Jermyn Street could be made available for the supply of that scientific instruction the need of which could not have been apprehended, or stated, more clearly than it was by them.

The heads of colleges in our great universities (who have not the reputation of being the most mobile of persons) have, in several cases, thought it well that, out of the great number of honours and rewards at their disposal, a few should hereafter be given to the cultivators of the physical sciences. Nay, I hear that some colleges have even gone so far as to appoint one, or, maybe, two special tutors for the purpose of putting the facts and principles of physical science before the undergraduate mind.

And I say it with gratitude and great respect for those eminent persons, that the head masters of our public schools, Eton, Harrow, Winchester, have addressed themselves to the problem of introducing instruction in physical science among the studies of those great educational bodies, with much honesty of purpose and enlightenment of understanding; and I live in hope that, before long, important changes in this direction will be carried into effect in those strongholds of ancient prescription. In fact, such changes have already been made, and physical science, even now, constitutes a recognized element of the school curriculum in Harrow and Rugby, whilst I understand that ample preparations for such studies are being made at Eton and elsewhere.

Looking at these facts, I might perhaps spare myself the trouble of giving any reasons for the introduction of physical science into elementary education; yet I cannot but think that it may be well if I place before you some considerations which, perhaps, have hardly received full attention.

At other times, and in other places, I have endeavoured to state the higher and more abstract arguments, by which the study of physical science may be shown to be indispensable to the complete training of the human mind; but I do not wish it to be supposed that, because I happen to be devoted to more or less abstract and "unpractical" pursuits, I am insensible to the weight which ought to be attached to that which has been said to be the English conception of Paradise — namely, "getting on." I look upon it, that "getting on" is a very important matter indeed. I do not mean merely for the sake of the coarse and tangible results of success, but because humanity is so constituted that a vast number of us would never be impelled to those stretches of exertion which make us wiser and more capable men, if it were not for the absolute necessity of putting on our faculties all the strain they will bear, for the purpose of "getting on" in the most practical sense.

Now the value of a knowledge of physical science as a means of getting on is indubitable. There are hardly any of our trades, except the merely huckstering ones, in which some knowledge of science may not be directly profitable to the pursuer of that occupation. As industry attains higher stages of its development, as its processes become more complicated and refined, and competition more keen, the sciences are dragged in, one by one, to take their share in the fray; and he who can best avail himself of their help is the man who will come out uppermost in that struggle for existence, which goes on as fiercely beneath the

smooth surface of modern society, as among the wild inhabitants of the woods.

But in addition to the bearing of science on ordinary practical life, let me direct your attention to its immense influence on several of the professions. I ask any one who has adopted the calling of an engineer, how much time he lost when he left school, because he had to devote himself to pursuits which were absolutely novel and strange, and of which he had not obtained the remotest conception from his instructors? He had to familiarise himself with ideas of the course and powers of Nature, to which his attention had never been directed during his school-life, and to learn, for the first time, what a world of facts lies outside and beyond the world of words. I appeal to those who know what engineering is, to say how far I am right in respect to that profession; but with regard to another, of no less importance, I shall venture to speak of my own knowledge. There is no one of us who may not at any moment be thrown, bound hand and foot by physical incapacity, into the hands of a medical practitioner. The chances of life and death for all and each of us may, at any moment, depend on the skill with which that practitioner is able to make out what is wrong in our bodily frames, and on his ability to apply the proper remedy to the defect.

The necessities of modern life are such, and the class from which the medical profession is chiefly recruited is so situated, that few medical men can hope to spend more than three or four, or it may be five, years in the pursuit of those studies which are immediately germane to physic. How is that all too brief period spent at present? I speak as an old examiner, having served some eleven or twelve years in that capacity in the University of London, and therefore having a practical acquaintance with the subject; but I might fortify myself by the authority of the President of the College of Surgeons, Mr. Quain, whom I heard the other day in an admirable address (the Hunterian Oration) deal fully and wisely with this very topic.*

* Mr. Quain's words (*Medical Times and Gazette*, February 20) are: —"A few words as to our special Medical course of instruction and the influence upon it of such changes in the elementary schools as I have mentioned. The student now enters at once upon several sciences — physics, chemistry, anatomy, physiology, botany, pharmacy, therapeutics — all these, the facts and the language and the laws of each, to be mastered in eighteen months. Up to the beginning of the Medical course many have learned little. We cannot claim anything better than the Examiner of the University of London and the Cambridge Lecturer have reported for their Universities. Supposing that at school young people had acquired some exact elementary knowledge of physics, chemistry, and a branch of natural history — say botany — with the physiology connected with it, they would then have gained necessary

A young man commencing the study of medicine is at once required to endeavour to make an acquaintance with a number of sciences, such as Physics, as Chemistry, as Botany, as Physiology, which are absolutely and entirely strange to him, however excellent his so-called education at school may have been. Not only is he devoid of all apprehension of scientific conceptions, not only does he fail to attach any meaning to the words "matter," "force," or "law" in their scientific senses, but, worse still, he has no notion of what it is to come into contact with Nature, or to lay his mind alongside of a physical fact, and try to conquer it, in the way our great naval hero told his captains to master their enemies. His whole mind has been given to books, and I am hardly exaggerating if I say that they are more real to him than Nature. He imagines that all knowledge can be got out of books, and rests upon the authority of some master or other; nor does he entertain any misgiving that the method of learning which led to proficiency in the rules of grammar will suffice to lead him to a mastery of the laws of Nature. The youngster, thus unprepared for serious study, is turned loose among his medical studies, with the result, in nine cases out of ten, that the first year of his curriculum is spent in learning how to learn. Indeed, he is lucky if, at the end of the first year, by the exertions of his teachers and his own industry, he has acquired even that art of arts. After which there remain not more than three, or perhaps four, years for the profitable study of such vast sciences as Anatomy, Physiology, Theapeutics, Medicine, Surgery, Obstetrics, and the like, upon his knowledge or ignorance of which it depends whether the practitioner shall diminish, or increase, the bills of mortality. Now what is it but the preposterous condition of ordinary school education which prevents a young man of seventeen, destined for the practice of medicine, from being fully prepared for the study of Nature; and from coming to the medical school, equipped with that preliminary knowledge of the principles of Physics, of Chemistry and of Biology, upon which he has now to waste one of the precious years, every moment of which ought to be given to those studies which bear directly upon the knowledge of his profession?

knowledge, with some practice in inductive reasoning. The whole studies are processes of observation and induction — the best discipline of the mind for the purposes of life — for our purposes not less than any. 'By such study (says Dr. Whewell) of one or more departments of inductive science the mind may escape from the thraldom of mere words.' By that plan the burden of the early Medical course would be much lightened, and more time devoted to practical studies, including Sir Thomas Watson's 'final and supreme stage' of the knowledge of Medicine."

There is another profession, to the members of which, I think, a certain preliminary knowledge of physical science might be quite as valuable as to the medical man. The practitioner of medicine sets before himself the noble object of taking care of man's bodily welfare; but the members of this other profession undertake to "minister to minds diseased," and, so far as may be, to diminish sin and soften sorrow. Like the medical profession, the clerical, of which I now speak, rests its power to heal upon its knowledge of the order of the universe — upon certain theories of man's relation to that which lies outside him. It is not my business to express any opinion about these theories. I merely wish to point out that, like all other theories, they are professedly based upon matters of fact. Thus the clerical profession has to deal with the facts of Nature from a certain point of view; and hence it comes into contact with that of the man of science, who has to treat the same facts from another point of view. You know how often that contact is to be described as collision, or violent friction; and how great the heat, how little the light, which commonly results from it.

In the interests of fair play, to say nothing of those of mankind, I ask, Why do not the clergy as a body acquire, as a part of their preliminary education, some such tincture of physical science as will put them in a position to understand the difficulties in the way of accepting their theories, which are forced upon the mind of every thoughtful and intelligent man, who has taken the trouble to instruct himself in the elements of natural knowledge?

Some time ago I attended a large meeting of the clergy, for the purpose of delivering an address which I had been invited to give. I spoke of some of the most elementary facts in physical science, and of the manner in which they directly contradict certain of the ordinary teachings of the clergy. The result was, that, after I had finished, one section of the assembled ecclesiastics attacked me with all the intemperance of pious zeal, for stating facts and conclusions which no competent judge doubts; while, after the first speakers had subsided, amidst the cheers of the great majority of their colleagues, the more rational minority rose to tell me that I had taken wholly superfluous pains, that they already knew all about what I had told them, and perfectly agreed with me. A hard-headed friend of mine, who was present, put the not unnatural question, "Then why don't you say so in your pulpits?" to which inquiry I heard no reply.

In fact the clergy are at present divisible into three sections: an immense body who are ignorant and speak out; a small pro-

portion who know and are silent; and a minute minority who know and speak according to their knowledge. By the clergy, I mean especially the Protestant clergy. Our great antagonist —I speak as a man of science— the Roman Catholic Church, the one great spiritual organisation which is able to resist, and must, as a matter of life and death, resist, the progress of science and modern civilisation, manages her affairs much better.

It was my fortune some time ago to pay a visit to one of the most important of the institutions in which the clergy of the Roman Catholic Church in these islands are trained; and it seemed to me that the difference between these men and the comfortable champions of Anglicanism and of Dissent, was comparable to the difference between our gallant Volunteers and the trained veterans of Napoleon's Old Guard.

The Catholic priest is trained to know his business, and do it effectually. The professors of the college in question, learned, zealous, and determined men, permitted me to speak frankly with them. We talked like outposts of opposed armies during a truce —as friendly enemies; and when I ventured to point out the difficulties their students would have to encounter from scientific thought, they replied: "Our Church has lasted many ages, and has passed safely through many storms. The present is but a new gust of the old tempest, and we do not turn out our young men less fitted to weather it, than they have been, in former times, to cope with the difficulties of those times. The heresies of the day are explained to them by their professors of philosophy and science, and they are taught how those heresies are to be met."

I heartily respect an organisation which faces its enemies in this way; and I wish that all ecclesiastical organisations were in as effective a condition. I think it would be better, not only for them, but for us. The army of liberal thought is, at present, in very loose order; and many a spirited free-thinker makes use of his freedom mainly to vent nonsense. We should be the better for a vigorous and watchful enemy to hammer us into cohesion and discipline; and I, for one, lament that the bench of Bishops cannot show a man of the calibre of Butler of the "Analogy," who, if he were alive, would make short work of much of the current *à priori* "infidelity."

I hope you will consider that the arguments I have now stated, even if there were no better ones, constitute a sufficient apology for urging the introduction of science into schools. The next question to which I have to address myself is, What sciences

ought to be thus taught? And this is one of the most important of questions, because my side (I am afraid I am a terribly candid friend) sometimes spoils its cause by going in for too much. There are other forms of culture beside physical science; and I should be profoundly sorry to see the fact forgotten, or even to observe a tendency to starve, or cripple, literary, or æsthetic, culture for the sake of science. Such a narrow view of the nature of education has nothing to do with my firm conviction that a complete and thorough scientific culture ought to be introduced into all schools. By this, however, I do not mean that every schoolboy should be taught everything in science. That would be a very absurd thing to conceive, and a very mischievous thing to attempt. What I mean is, that no boy nor girl should leave school without possessing a grasp of the general character of science, and without having been disciplined, more or less, in the methods of all sciences; so that, when turned into the world to make their own way, they shall be prepared to face scientific problems, not by knowing at once the conditions of every problem, or by being able at once to solve it; but by being familiar with the general current of scientific thought, and by being able to apply the methods of science in the proper way, when they have acquainted themselves with the conditions of the special problem.

That is what I understand by scientific education. To furnish a boy with such an education, it is by no means necessary that he should devote his whole school existence to physical science: in fact, no one would lament so one-sided a proceeding more than I. Nay more, it is not necessary for him to give up more than a moderate share of his time to such studies, if they be properly selected and arranged, and if he be trained in them in a fitting manner.

I conceive the proper course to be somewhat as follows. To begin with, let every child be instructed in those general views of the phænomena of Nature for which we have no exact English name. The nearest approximation to a name for what I mean, which we possess, is "physical geography." The Germans have a better, "Erdkunde" ("earth knowledge" or "geology" in its etymological sense), that is to say, a general knowledge of the earth, and what is on it, in it, and about it. If any one who has had experience of the ways of young children will call to mind their questions, he will find that so far as they can be put into any scientific category, they come under this head of "Erdkunde." The child asks, "What is the moon, and why does it shine?" "What is this water, and where does it run?" "What is the wind?" "What makes this wave in the sea?" "Where does this

animal live, and what is the use of that plant?" And if not snubbed and stunted by being told not to ask foolish questions, there is no limit to the intellectual craving of a young child; nor any bounds to the slow, but solid, accretion of knowledge and development of the thinking faculty in this way. To all such questions, answers which are necessarily incomplete, though true as far as they go, may be given by any teacher whose ideas represent real knowledge and not mere book learning; and a panoramic view of Nature, accompanied by a strong infusion of the scientific habit of mind, may thus be placed within the reach of every child of nine or ten.

After this preliminary opening of the eyes to the great spectacle of the daily progress of Nature, as the reasoning faculties of the child grow, and he becomes familiar with the use of the tools of knowledge — reading, writing, and elementary mathematics — he should pass on to what is, in the more strict sense, physical science. Now there are two kinds of physical science: the one regards form and the relation of forms to one another; the other deals with causes and effects. In many of what we term sciences, these two kinds are mixed up together; but systematic botany is a pure example of the former kind, and physics of the latter kind, of science. Every educational advantage which training in physical science can give is obtainable from the proper study of these two; and I should be contented, for the present, if they, added to our "Erdkunde," furnished the whole of the scientific curriculum of school. Indeed, I conceive it would be one of the greatest boons which could be conferred upon England, if henceforward every child in the country were instructed in the general knowledge of the things about it, in the elements of physics, and of botany. But I should be still better pleased if there could be added somewhat of chemistry, and an elementary acquaintance with human physiology.

So far as school education is concerned, I want to go no further just now; and I believe that such instruction would make an excellent introduction to that preparatory scientific training which, as I have indicated, is so essential for the successful pursuit of our most important professions. But this modicum of instruction must be so given as to ensure real knowledge and practical discipline. If scientific education is to be dealt with as mere bookwork, it will be better not to attempt it, but to stick to the Latin Grammar which makes no pretence to be anything but bookwork.

If the great benefits of scientific training are sought, it is essential that such training should be real: that is to say, that the

mind of the scholar should be brought into direct relation with fact, that he should not merely be told a thing, but made to see by the use of his own intellect and ability that the thing is so and no otherwise. The great peculiarity of scientific training, that in virtue of which it cannot be replaced by any other discipline whatsoever, is this bringing of the mind directly into contact with fact, and practising the intellect in the completest form of induction; that is to say, in drawing conclusions from particular facts made known by immediate observation of Nature.

The other studies which enter into ordinary education do not discipline the mind in this way. Mathematical training is almost purely deductive. The mathematician starts with a few simple propositions, the proof of which is so obvious that they are called self-evident, and the rest of his work consists of subtle deductions from them. The teaching of languages, at any rate as ordinarily practised, is of the same general nature,— authority and tradition furnish the data, and the mental operations of the scholar are deductive.

Again: if history be the subject of study, the facts are still taken upon the evidence of tradition and authority. You cannot make a boy see the battle of Thermopylæ for himself, or know, of his own knowledge, that Cromwell once ruled England. There is no getting into direct contact with natural fact by this road; there is no dispensing with authority, but rather a resting upon it.

In all these respects, science differs from other educational discipline, and prepares the scholar for common life. What have we to do in every-day life? Most of the business which demands our attention is matter of fact, which needs, in the first place, to be accurately observed or apprehended; in the second, to be interpreted by inductive and deductive reasonings, which are altogether similar in their nature to those employed in science. In the one case, as in the other, whatever is taken for granted is so taken at one's own peril; fact and reason are the ultimate arbiters, and patience and honesty are the great helpers out of difficulty.

But if scientific training is to yield its most eminent results, it must, I repeat, be made practical. That is to say, in explaining to a child the general phænomena of Nature, you must, as far as possible, give reality to your teaching by object-lessons; in teaching him botany, he must handle the plants and dissect the flowers for himself; in teaching him physics and chemistry, you must not be solicitous to fill him with information, but you must be careful that what he learns he knows of his own knowledge. Don't be satisfied with telling him that a magnet attracts iron. Let him see that it does; let him feel the pull of the one upon the

other for himself. And, especially, tell him that it is his duty to doubt until he is compelled, by the absolute authority of Nature, to believe that which is written in books. Pursue this discipline carefully and conscientiously, and you may make sure that, however scanty may be the measure of information which you have poured into the boy's mind, you have created an intellectual habit of priceless value in practical life.

One is constantly asked, When should this scientific education be commenced? I should say with the dawn of intelligence. As I have already said, a child seeks for information about matters of physical science as soon as it begins to talk. The first teaching it wants is an object-lesson of one sort or another; and as soon as it is fit for systematic instruction of any kind, it is fit for a modicum of science.

People talk of the difficulty of teaching young children such matters, and in the same breath insist upon their learning their Catechism, which contains propositions far harder to comprehend than anything in the educational course I have proposed. Again: I am incessantly told that we, who advocate the introduction of science in schools, make no allowance for the stupidity of the average boy or girl; but, in my belief, that stupidity, in nine cases out of ten, "*fit, non nascitur*," and is developed by a long process of parental and pedagogic repression of the natural intellectual appetites, accompanied by a persistent attempt to create artificial ones for food which is not only tasteless, but essentially indigestible.

Those who urge the difficulty of instructing young people in science are apt to forget another very important condition of success — important in all kinds of teaching, but most essential, I am disposed to think, when the scholars are very young. This condition is, that the teacher should himself really and practically know his subject. If he does, he will be able to speak of it in the easy language, and with the completeness of conviction, with which he talks of any ordinary every-day matter. If he does not, he will be afraid to wander beyond the limits of the technical phraseology which he has got up; and a dead dogmatism, which oppresses, or raises opposition, will take the place of the lively confidence, born of personal conviction, which cheers and encourages the eminently sympathetic mind of childhood.

I have already hinted that such scientific training as we seek for may be given without making any extravagant claim upon the time now devoted to education. We ask only for "a most favoured nation" clause in our treaty with the schoolmaster; we demand no more than that science shall have as much time

given to it as any other single subject — say four hours a week in each class of an ordinary school.

For the present, I think men of science would be well content with such an arrangement as this; but speaking for myself, I do not pretend to believe that such an arrangement can be, or will be, permanent. In these times the educational tree seems to me to have its roots in the air, its leaves and flowers in the ground; and, I confess, I should very much like to turn it upside down, so that its roots might be solidly embedded among the facts of Nature, and draw thence a sound nutriment for the foliage and fruit of literature and of art. No educational system can have a claim to permanence, unless it recognises the truth that education has two great ends to which everything else must be subordinated. The one of these is to increase knowledge; the other is to develop the love of right and the hatred of wrong.

With wisdom and uprightness a nation can make its way worthily, and beauty will follow in the footsteps of the two, even if she be not specially invited; while there is perhaps no sight in the whole world more saddening and revolting than is offered by men sunk in ignorance of everything but what other men have written; seemingly devoid of moral belief or guidance; but with the sense of beauty so keen, and the power of expression so cultivated, that their sensual caterwauling may be almost mistaken for the music of the spheres.

At present, education is almost entirely devoted to the cultivation of the power of expression, and of the sense of literary beauty. The matter of having anything to say, beyond a hash of other people's opinions, or of possessing any criterion of beauty, so that we may distinguish between the Godlike and the devilish, is left aside as of no moment. I think I do not err in saying that if science were made a foundation of education, instead of being, at most, stuck on as cornice to the edifice, this state of things could not exist.

In advocating the introduction of physical science as a leading element in education, I by no means refer only to the higher schools. On the contrary, I believe that such a change is even more imperatively called for in those primary schools, in which the children of the poor are expected to turn to the best account the little time they can devote to the acquisition of knowledge. A great step in this direction has already been made by the establishment of science-classes under the Department of Science and Art,— a measure which came into existence unnoticed, but which will, I believe, turn out to be of more importance to

the welfare of the people than many political changes over which the noise of battle has rent the air.

Under the regulations to which I refer, a schoolmaster can set up a class in one or more branches of science; his pupils will be examined, and the State will pay him, at a certain rate, for all who succeed in passing. I have acted as an examiner under this system from the beginning of its establishment, and this year I expect to have not fewer than a couple of thousand sets of answers to questions in Physiology, mainly from young people of the artisan class, who have been taught in the schools which are now scattered all over Great Britain and Ireland. Some of my colleagues, who have to deal with subjects such as Geometry, for which the present teaching power is better organised, I understand are likely to have three or four times as many papers. So far as my own subjects are concerned, I can undertake to say that a great deal of the teaching, the results of which are before me in these examinations, is very sound and good; and I think it is in the power of the examiners, not only to keep up the present standard, but to cause an almost unlimited improvement. Now what does this mean? It means that by holding out a very moderate inducement, the masters of primary schools in many parts of the country have been led to convert them into little foci of scientific instruction; and that they and their pupils have contrived to find, or to make, time enough to carry out this object with a very considerable degree of efficiency. That efficiency will, I doubt not, be very much increased as the system becomes known and perfected, even with the very limited leisure left to masters and teachers on week-days. And this leads me to ask, Why should scientific teaching be limited to week-days?

Ecclesiastically-minded persons are in the habit of calling things they do not like by very hard names, and I should not wonder if they brand the proposition I am about to make as blasphemous, and worse. But, not minding this, I venture to ask, Would there really be anything wrong in using part of Sunday for the purpose of instructing those who have no other leisure, in a knowledge of the phænomena of Nature, and of man's relation to Nature?

I should like to see a scientific Sunday-school in every parish, not for the purpose of superseding any existing means of teaching the people the things that are for their good, but side by side with them. I cannot but think that there is room for all of us to work in helping to bridge over the great abyss of ignorance which lies at our feet.

And if any of the ecclesiastical persons to whom I have referred object that they find it derogatory to the honour of the God whom they worship, to awaken the minds of the young to the infinite wonder and majesty of the works which they proclaim His, and to teach them those laws which must needs be His laws, and therefore of all things needful for man to know — I can only recommend them to be let blood and put on low diet. There must be something very wrong going on in the instrument of logic if it turns out such conclusions from such premises.

VI.

SCIENCE AND CULTURE.

SIX years ago, as some of my present hearers may remember, I had the privilege of addressing a large assemblage of the inhabitants of this city, who had gathered together to do honour to the memory of their famous townsman, Joseph Priestley;* and, if any satisfaction attaches to posthumous glory, we may hope that the manes of the burnt-out philosopher were then finally appeased.

No man, however, who is endowed with a fair share of common sense, and not more than a fair share of vanity, will identify either contemporary or posthumous fame with the highest good; and Priestley's life leaves no doubt that he, at any rate, set a much higher value upon the advancement of knowledge, and the promotion of that freedom of thought which is at once the cause and the consequence of intellectual progress.

Hence I am disposed to think that, if Priestley could be amongst us to-day, the occasion of our meeting would afford him even greater pleasure than the proceedings which celebrated the centenary of his chief discovery. The kindly heart would be moved, the high sense of social duty would be satisfied, by the spectacle of well-earned wealth neither squandered in tawdry luxury and vainglorious show, nor scattered with the careless charity which blesses neither him that gives nor him that takes, but expended in the execution of a well-considered plan for the aid of present and future generations of those who are willing to help themselves.

We shall all be of one mind thus far. But it is needful to share Priestley's keen interest in physical science; and to have learned, as he had learned, the value of scientific training in fields of inquiry apparently far remote from physical science; in order to appreciate, as he would have appreciated, the value of the noble gift which Sir Josiah Mason has bestowed upon the inhabitants of the Midland district.

For us children of the nineteenth century, however, the establishment of a college under the conditions of Sir Josiah Mason's

* Birmingham.

Trust, has a significance apart from any which it could have possessed a hundred years ago. It appears to be an indication that we are reaching the crisis of the battle, or rather of the long series of battles, which have been fought over education in a campaign which began long before Priestley's time, and will probably not be finished just yet.

In the last century, the combatants were the champions of ancient literature on the one side, and those of modern literature on the other; but, some thirty years* ago, the contest became complicated by the appearance of a third army, ranged round the banner of Physical Science.

I am not aware that any one has authority to speak in the name of this new host. For it must be admitted to be somewhat of a guerilla force, composed largely of irregulars, each of whom fights pretty much for his own hand. But the impressions of a full private, who has seen a good deal of service in the ranks, respecting the present position of affairs and the conditions of a permanent peace, may not be devoid of interest; and I do not know that I could make a better use of the present opportunity than by laying them before you.

From the time that the first suggestion to introduce physical science into ordinary education was timidly whispered, until now, the advocates of scientific education have met with opposition of two kinds. On the one hand, they have been pooh-poohed by the men of business who pride themselves on being the representatives of practicality; while, on the other hand, they have been excommunicated by the classical scholars, in their capacity of Levites in charge of the ark of culture and monopolists of liberal education.

The practical men believed that the idol whom they worship — rule of thumb — has been the source of the past prosperity, and will suffice for the future welfare of the arts and manufactures. They were of opinion that science is speculative rubbish; that theory and practice have nothing to do with one another; and that the scientific habit of mind is an impediment, rather than an aid, in the conduct of ordinary affairs.

I have used the past tense in speaking of the practical men — for although they were very formidable thirty years ago, I am not sure that the pure species has not been extirpated. In fact, so far as mere argument goes, they have been subjected to such

*The advocacy of the introduction of physical science into general education by George Combe and others commenced a good deal earlier; but the movement had acquired hardly any practical force before the time to which I refer.

a *feu d'enfer* that it is a miracle if any have escaped. But I have remarked that your typical practical man has an unexpected resemblance to one of Milton's angels. His spiritual wounds, such as are inflicted by logical weapons, may be as deep as a well and as wide as a church door, but beyond shedding a few drops of ichor, celestial or otherwise, he is no whit the worse. So, if any of these opponents be left, I will not waste time in vain repetition of the demonstrative evidence of the practical value of science; but knowing that a parable will sometimes penetrate where syllogisms fail to effect an entrance, I will offer a story for their consideration.

Once upon a time, a boy, with nothing to depend upon but his own vigorous nature, was thrown into the thick of the struggle for existence in the midst of a great manufacturing population. He seems to have had a hard fight, inasmuch as, by the time he was thirty years of age, his total disposable funds amounted to twenty pounds. Nevertheless, middle life found him giving proof of his comprehension of the practical problems he had been roughly called upon to solve, by a career of remarkable prosperity.

Finally, having reached old age with its well-earned surroundings of "honour, troops of friends," the hero of my story bethought himself of those who were making a like start in life, and how he could stretch out a helping hand to them.

After long and anxious reflection this successful practical man of business could devise nothing better than to provide them with the means of obtaining "sound, extensive, and practical scientific knowledge." And he devoted a large part of his wealth and five years of incessant work to this end.

I need not point the moral of a tale which, as the solid and spacious fabric of the Scientific College assures us, is no fable, nor can anything which I could say intensify the force of this practical answer to practical objections.

We may take it for granted then, that, in the opinion of those best qualified to judge, the diffusion of thorough scientific education is an absolutely essential condition of industrial progress; and that the College which has been opened to-day will confer an inestimable boon upon those whose livelihood is to be gained by the practise of the arts and manufactures of the district.

The only question worth discussion is, whether the conditions, under which the work of the College is to be carried out, are such as to give it the best possible chance of achieving permanent success.

Sir Josiah Mason, without doubt most wisely, has left very large freedom of action to the trustees, to whom he proposes ultimately to commit the administration of the College, so that they may be able to adjust its arrangements in accordance with the changing conditions of the future. But, with respect to three points, he has laid most explicit injunctions upon both administrators and teachers.

Party politics are forbidden to enter into the minds of either, so far as the work of the College is concerned; theology is as sternly banished from its precincts; and finally, it is especially declared that the College shall make no provision for "mere literary instruction and education."

It does not concern me at present to dwell upon the first two injunctions any longer than may be needful to express my full conviction of their wisdom. But the third prohibition brings us face to face with those other opponents of scientific education, who are by no means in the moribund condition of the practical man, but alive, alert, and formidable.

It is not impossible that we shall hear this express exclusion of "literary instruction and education" from a College which, nevertheless, professes to give a high and efficient education, sharply criticised. Certainly the time was that the Levites of culture would have sounded their trumpets against its walls as against an educational Jericho.

How often have we not been told that the study of physical science is incompetent to confer culture; that it touches none of the higher problems of life; and, what is worse, that the continual devotion to scientific studies tends to generate a narrow and bigoted belief in the applicability of scientific methods to the search after truth of all kinds? How frequently one has reason to observe that no reply to a troublesome argument tells so well as calling its author a "mere scientific specialist." And, as I am afraid it is not permissible to speak of this form of opposition to scientific education in the past tense; may we not expect to be told that this, not only omission, but prohibition, of "mere literary instruction and education" is a patent example of scientific narrow-mindedness?

I am not acquainted with Sir Josiah Mason's reasons for the action which he has taken; but if, as I apprehend is the case, he refers to the ordinary classical course of our schools and universities by the name of "mere literary instruction and education," I venture to offer sundry reasons of my own in support of that action.

For I hold very strongly by two convictions — The first is

that neither the discipline nor the subject-matter of classical education is of such direct value to the student of physical science as to justify the expenditure of valuable time upon either; and the second is, that for the purpose of attaining real culture, an exclusively scientific education is at least as effectual as an exclusively literary education.

I need hardly point out to you that these opinions, especially the latter, are diametrically opposed to those of the great majority of educated Englishmen, influenced as they are by school and university traditions. In their belief, culture is obtainable only by a liberal education; and a liberal education is synonymous, not merely with education and instruction in literature, but in one particular form of literature, namely, that of Greek and Roman antiquity. They hold that the man who has learned Latin and Greek, however little, is educated; while he who is versed in other branches of knowledge, however deeply, is a more or less respectable specialist, not admissible into the cultured caste. The stamp of the educated man, the University degree, is not for him.

I am too well acquainted with the generous catholicity of spirit, the true sympathy with scientific thought, which pervades the writings of our chief apostle of culture to identify him with these opinions; and yet one may cull from one and another of those epistles to the Philistines, which so much delight all who do not answer to that name, sentences which lend them some support.

Mr. Arnold tells us that the meaning of culture is "to know the best that has been thought and said in the world." It is the criticism of life contained in literature. That criticism regards "Europe as being, for intellectual and spiritual purposes, one great confederation, bound to a joint action and working to a common result; and whose members have, for their common outfit, a knowledge of Greek, Roman, and Eastern antiquity, and of one another. Special, local, and temporary advantages being put out of account, that modern nation will in the intellectual and spiritual sphere make most progress, which most thoroughly carries out this programme. And what is that but saying that we too, all of us, as individuals, the more thoroughly we carry it out, shall make the more progress?" *

We have here to deal with two distinct propositions. The first, that a criticism of life is the essence of culture; the second, that literature contains the materials which suffice for the construction of such criticism.

I think that we must all assent to the first proposition. For culture certainly means something quite different from learning

* *Essays in Criticism.* p. 37.

or technical skill. It implies the possession of an ideal, and the habit of critically estimating the value of things by comparison with a theoretic standard. Perfect culture should supply a complete theory of life, based upon a clear knowledge alike of its possibilities and of its limitations.

But we may agree to all this, and yet strongly dissent from the assumption that literature alone is competent to supply this knowledge. After having learnt all that Greek, Roman, and Eastern antiquity have thought and said, and all that modern literature have to tell us, it is not self-evident that we have laid a sufficiently broad and deep foundation for that criticism of life, which constitutes culture.

Indeed, to any one acquainted with the scope of physical science, it is not at all evident. Considering progress only in the "intellectual and spiritual sphere," I find myself wholly unable to admit that either nations or individuals will really advance, if their common outfit draws nothing from the stores of physical science. I should say that an army, without weapons of precision and with no particular base of operations, might more hopefully enter upon a campaign on the Rhine, than a man, devoid of a knowledge of what physical science has done in the last century, upon a criticism of life.

When a biologist meets with an anomaly, he instinctively turns to the study of development to clear it up. The rationale of contradictory opinions may with equal confidence be sought in history.

It is, happily, no new thing that Englishmen should employ their wealth in building and endowing institutions for educational purposes. But, five or six hundred years ago, deeds of foundation expressed or implied conditions as nearly as possible contrary to those which have been thought expedient by Sir Josiah Mason. That is to say, physical science was practically ignored, while a certain literary training was enjoined as a means to the acquirement of knowledge which was essentially theological.

The reason of this singular contradiction between the actions of men alike animated by a strong and disinterested desire to promote the welfare of their fellows, is easily discovered.

At that time, in fact, if any one desired knowledge beyond such as could be obtained by his own observation, or by common conversation, his first necessity was to learn the Latin language, inasmuch as all the higher knowledge of the western world was contained in works written in that language. Hence, Latin grammar, with logic and rhetoric, studied through Latin, were the

fundamentals of education. With respect to the substance of the knowledge imparted through this channel, the Jewish and Christian Scriptures, as interpreted and supplemented by the Romish Church, were held to contain a complete and infallibly true body of information.

Theological dicta were, to the thinkers of those days, that which the axioms and definitions of Euclid are to the geometers of these. The business of the philosophers of the middle ages was to deduce from the data furnished by the theologians, conclusions in accordance with ecclesiastial decrees. They were allowed the high privilege of showing, by logical process, how and why that which the Church said was true, must be true. And if their demonstrations fell short of or exceeded this limit, the Church was maternally ready to check their aberrations; if need were by the help of the secular arm.

Between the two our ancestors were furnished with a compact and complete criticism of life. They were told how the world began and how it would end; they learned that all material existence was but a base and insignificant blot upon the fair face of the spiritual world, and that nature was, to all intents and purposes, the play-ground of the devil; they learned that the earth is the centre of the visible universe, and that man is the cynosure of things terrestrial, and more especially was it inculcated that the course of nature had no fixed order, but that it could be, and constantly was, altered by the agency of innumerable spiritual beings, good and bad, according as they were moved by the deeds and prayers of men. The sum and substance of the whole doctrine was to produce the conviction that the only thing really worth knowing in this world was how to secure that place in a better which, under certain conditions, the Church promised.

Our ancestors had a living belief in this theory of life, and acted upon it in their dealings with education, as in all other matters. Culture meant saintliness — after the fashion of the saints of those days; the education that led to it was, of necessity, theological; and the way of theology lay through Latin.

That the study of nature — further than was requisite for the satisfaction of everyday wants — should have any bearing on human life was far from the thoughts of men thus trained. Indeed, as nature had been cursed for man's sake, it was an obvious conclusion that those who meddled with nature were likely to come into pretty close contact with Satan. And, if any born scientific investigator followed his instincts, he might safely reckon upon earning the reputation, and probably upon suffering the fate of a sorcerer.

Had the western world been left to itself in Chinese isolation, there is no saying how long this state of things might have endured. But, happily, it was not left to itself. Even earlier than the thirteenth century, the development of Moorish civilisation in Spain and the great movement of the Crusades had introduced the leaven which, from that day to this, has never ceased to work. At first, through the intermediation of Arabic translations, afterwards by the study of the originals, the western nations of Europe became acquainted with the writings of the ancient philosophers and poets, and, in time, with the whole of the vast literature of antiquity.

Whatever there was of high intellectual aspiration or dominant capacity in Italy, France, Germany, and England, spent itself for centuries in taking possession of the rich inheritance left by the dead civilisations of Greece and Rome. Marvellously aided by the invention of printing, classical learning spread and flourished. Those who possessed it prided themselves on having attained the highest culture then within the reach of mankind.

And justly. For, saving Dante on his solitary pinnacle, there was no figure in modern literature at the time of the Renascence to compare with the men of antiquity; there was no art to compete with their sculpture; there was no physical science but that which Greece had created. Above all, there was no other example of perfect intellectual freedom — of the unhesitating acceptance of reason as the sole guide to truth and the supreme arbiter of conduct.

The new learning necessarily soon exerted a profound influence upon education. The language of the monks and schoolmen seemed little better than gibberish to scholars fresh from Virgil and Cicero, and the study of Latin was placed upon a new foundation. Moreover, Latin itself ceased to afford the sole key to knowledge. The student who sought the highest thought of antiquity, found only a second-hand reflection of it in Roman literature, and turned his face to the full light of the Greeks. And after a battle, not altogether dissimilar to that which is at present being fought over the teaching of physical science, the study of Greek was recognised as an essential element of all higher education.

Then the Humanists, as they were called, won the day; and the great reform which they effected was of incalculable service to mankind. But the Nemesis of all reformers is finality; and the reformers of education, like those of religion, fell into the profound, however common, error of mistaking the beginning for the end of the work of reformation.

The representatives of the Humanists, in the nineteenth century, take their stand upon classical education as the sole avenue to culture, as firmly as if we were still in the age of Renascence. Yet, surely, the present intellectual relations of the modern and the ancient worlds are profoundly different from those which obtained three centuries ago. Leaving aside the existence of a great and characteristically modern literature, of modern painting, and, especially, of modern music, there is one feature of the present state of the civilised world which separates it more widely from the Renascence, than the Renascence was separated from the middle ages.

This distinctive character of our own times lies in the vast and constantly increasing part which is played by natural knowledge. Not only is our daily life shaped by it, not only does the prosperity of millions of men depend upon it, but our whole theory of life has long been influenced, consciously or unconsciously, by the general conceptions of the universe, which have been forced upon us by physical science.

In fact, the most elementary acquaintance with the results of scientific investigation shows us that they offer a broad and striking contradiction to the opinion so implicitly credited and taught in the middle ages.

The notions of the beginning and the end of the world entertained by our forefathers are no longer credible. It is very certain that the earth is not the chief body in the material universe, and that the world is not subordinated to man's use. It is even more certain that nature is the expression of a definite order with which nothing interferes, and that the chief business of mankind is to learn that order and govern themselves accordingly. Moreover this scientific "criticism of life" presents itself to us with different credentials from any other. It appeals not to authority, nor to what anybody may have thought or said, but to nature. It admits that all our interpretations of natural fact are more or less imperfect and symbolic, and bids the learner seek for truth not among words but among things. It warns us that the assertion which outstrips evidence is not only a blunder but a crime.

The purely classical education advocated by the representatives of the Humanists in our day, gives no inkling of all this. A man may be a better scholar than Erasmus, and know no more of the chief causes of the present intellectual fermentation than Erasmus did. Scholarly and pious persons, worthy of all respect, favour us with allocutions upon the sadness of the antagonism of science to their mediæval way of thinking, which betray an



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ignorance of the first principles of scientific investigation, an incapacity for understanding what a man of science means by veracity, and an unconsciousness of the weight of established scientific truths, which is almost comical.

There is no great force in the *tu quoque* argument, or else the advocates of scientific education might fairly enough retort upon the modern Humanists that they may be learned specialists, but that they possess no such sound foundation for a criticism of life as deserves the name of culture. And, indeed, if we were disposed to be cruel, we might urge that the Humanists have brought this reproach upon themselves, not because they are too full of the spirit of the ancient Greek, but because they lack it.

The period of the Renascence is commonly called that of the "Revival of Letters," as if the influences then brought to bear upon the mind of Western Europe had been wholly exhausted in the field of literature. I think it is very commonly forgotten that the revival of science, effected by the same agency, although less conspicuous, was not less momentous.

In fact, the few and scattered students of nature of that day picked up the clue to her secrets exactly as it fell from the hands of the Greeks a thousand years before. The foundations of mathematics were so well laid by them, that our children learn their geometry from a book written for the schools of Alexandria two thousand years ago. Modern astronomy is the natural continuation and development of the work of Hipparchus and of Ptolemy; modern physics of that of Democritus and of Archimedes; it was long before modern biological science outgrew the knowledge bequeathed to us by Aristotle, by Theophrastus, and by Galen.

We cannot know all the best thoughts and sayings of the Greeks unless we know what they thought about natural phænomena. We cannot fully apprehend their criticism of life unless we understand the extent to which that criticism was affected by scientific conceptions. We falsely pretend to be the inheritors of their culture, unless we are penetrated, as the best minds among them were, with an unhesitating faith that the free employment of reason, in accordance with scientific method, is the sole method of reaching truth.

Thus I venture to think that the pretensions of our modern Humanists to the possession of the monopoly of culture and to the exclusive inheritance of the spirit of antiquity must be abated, if not abandoned. But I should be very sorry that anything I have said should be taken to imply a desire on my part to depreciate the value of classical education, as it might be and as it

sometimes is. The native capacities of mankind vary no less than their opportunities; and while culture is one, the road by which one man may best reach it is widely different from that which is most advantageous to another. Again, while scientific education is yet inchoate and tentative, classical education is thoroughly well organised upon the practical experience of generations of teachers. So that, given ample time for learning and estimation for ordinary life, or for a literary career, I do not think that a young Englishman in search of culture can do better than follow the course usually marked out for him, supplementing its deficiencies by his own efforts.

But for those who mean to make science their serious occupation; or who intend to follow the profession of medicine; or who have to enter early upon the business of life; for all these, in my opinion, classical education is a mistake; and it is for this reason that I am glad to see "mere literary education and instruction" shut out from the curriculum of Sir Josiah Mason's College, seeing that its inclusion would probably lead to the introduction of the ordinary smattering of Latin and Greek.

Nevertheless, I am the last person to question the importance of genuine literary education, or to suppose that intellectual culture can be complete without it. An exclusively scientific training will bring about a mental twist as surely as an exclusively literary training. The value of the cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that the Scientific College would turn out none but lopsided men.

There is no need, however, that such a catastrophe should happen. Instruction in English, French, and German is provided, and thus the three greatest literatures of the modern world are made accessible to the student.

French and German, and especially the latter language, are absolutely indispensable to those who desire full knowledge in any department of science. But even supposing that the knowledge of these languages acquired is not more than sufficient for purely scientific purposes, every Englishman has, in his native tongue, an almost perfect instrument of literary expression; and, in his own literature, models of every kind of literary excellence. If an Englishman cannot get literary culture out of his Bible, his Shakespeare, his Milton, neither, in my belief, will the profoundest study of Homer and Sophocles, Virgil and Horace, give it to him.

Thus, since the constitution of the College makes sufficient provision for literary as well as for scientific education, and since

artistic instruction is also contemplated, it seems to me that a fairly complete culture is offered to all who are willing to take advantage of it.

But I am not sure that at this point the "practical" man, scotched but not slain, may ask what all this talk about culture has to do with an Institution, the object of which is defined to be "to promote the prosperity of the manufactures and the industry of the country." He may suggest that what is wanted for this end is not culture, nor even a purely scientific discipline, but simply a knowledge of applied science.

I often wish that this phrase, "applied science," had never been invented. For it suggests that there is a sort of scientific knowledge of direct practical use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed "pure science." But there is no more complete fallacy than this. What people call applied science is nothing but the application of pure science to particular classes of problems. It consists of deductions from those general principles, established by reasoning and observation, which constitute pure science. No one can safely make these deductions until he has a firm grasp of the principles; and he can obtain that grasp only by personal experience of the operations of observation and of reasoning on which they are founded.

Almost all the processes employed in the arts and manufactures fall within the range either of physics or of chemistry. In order to improve them, one must thoroughly understand them; and no one has a chance of really understanding them, unless he has obtained that mastery of principles and that habit of dealing with facts, which is given by long-continued and well-directed purely scientific training in the physical and the chemical laboratory. So that there really is no question as to the necessity of purely scientific discipline, even if the work of the College were limited by the narrowest interpretation of its stated aims.

And, as to the desirableness of a wider culture than that yielded by science alone, it is to be recollected that the improvement of manufacturing processes is only one of the conditions which contribute to the prosperity of industry. Industry is a means and not an end; and mankind work only to get something which they want. What that something is depends partly on their innate, and partly on their acquired, desires.

If the wealth resulting from prosperous industry is to be spent upon the gratification of unworthy desires, if the increasing perfection of manufacturing processes is to be accompanied by an

increasing debasement of those who carry them on, I do not see the good of industry and prosperity.

Now it is perfectly true that men's views of what is desirable depend upon their characters; and that the innate proclivities to which we give that name are not touched by any amount of instruction. But it does not follow that even mere intellectual education may not, to an indefinite extent, modify the practical manifestation of the characters of men in their actions, by supplying them with motives unknown to the ignorant. A pleasure-loving character will have pleasure of some sort; but, if you give him the choice, he may prefer pleasures which do not degrade him to those which do. And this choice is offered to every man, who possesses in literary or artistic culture a never-failing source of pleasures, which are neither withered by age, nor staled by custom, nor embittered in the recollection by the pangs of self-reproach.

If the Institution opened to-day fulfils the intention of its founder, the picked intelligences among all classes of the population of this district will pass through it. No child born in Birmingham, henceforward, if he have the capacity to profit by the opportunities offered to him, first in the primary and other schools, and afterwards in the Scientific College, need fail to obtain, not merely the instruction, but the culture most appropriate to the conditions of his life.

Within these walls, the future employer and the future artisan may sojourn together for a while, and carry, through all their lives, the stamp of the influences then brought to bear upon them. Hence, it is not beside the mark to remind you, that the prosperity of industry depends not merely upon the improvement of manufacturing processes, not merely upon the ennobling of the individual character, but upon a third condition, namely, a clear understanding of the conditions of social life, on the part of both the capitalist and the operative, and their agreement upon common principles of social action. They must learn that social phænomena are as much the expression of natural laws as any others; that no social arrangements can be permanent unless they harmonise with the requirements of social statics and dynamics; and that, in the nature of things, there is an arbiter whose decisions execute themselves.

But this knowledge is only to be obtained by the application of the methods of investigation adopted in physical researches to the investigation of the phænomena of society. Hence, I confess, I should like to see one addition made to the excellent scheme of education propounded for the College, in the shape of pro-

vision for the teaching of Sociology. For though we are all agreed that party politics are to have no place in the instruction of the College; yet in this country, practically governed as it is now by universal suffrage, every man who does his duty must exercise political functions. And, if the evils which are inseparable from the good of political liberty are to be checked, if the perpetual oscillation of nations between anarchy and despotism is to be replaced by the steady march of self-restraining freedom; it will be because men will gradually bring themselves to deal with political, as they now deal with scientific questions; to be as ashamed of undue haste and partisan prejudice in the one case as in the other; and to believe that the machinery of society is at least as delicate as that of a spinning-jenny, and as little likely to be improved by the meddling of those who have not taken the trouble to master the principles of its action.

In conclusion, I am sure that I make myself the mouthpiece of all present in offering to the venerable founder of the Institution, which now commences its beneficent career, our congratulations on the completion of his work; and in expressing the conviction, that the remotest posterity will point to it as a crucial instance of the wisdom which natural piety leads all men to ascribe to their ancestors.

VII.

ON SCIENCE AND ART IN RELATION TO EDUCATION.

WHEN a man is honoured by such a request as that which reached me from the authorities of your institution some time ago, I think the first thing that occurs to him is that which occurred to those who were bidden to the feast in the Gospel — to begin to make an excuse; and probably all the excuses suggested on that famous occasion crop up in his mind one after the other, including his "having married a wife," as reasons for not doing what he was asked to do. But, in my own case, and on this particular occasion, there were other difficulties of a sort peculiar to the time, and more or less personal to myself; because I felt that, if I came amongst you, I should be expected, and, indeed, morally compelled, to speak upon the subject of Scientific Education. And then there arose in my mind the recollection of a fact, which probably no one here by myself remembers; namely, that some fourteen years ago I was a guest of a citizen of yours, who bears the honoured name of Rathbone, at a very charming and pleasant dinner given by the Philomathic Society; and there and then, and in this very city, made a speech upon the topic of Scientific Education. Under these circumstances, you see, one runs two dangers — the first, of repeating one's self, although I may fairly hope that everybody has forgotten the fact I have just now mentioned, except myself; and the second, and even greater difficulty, is the danger of saying something different from what one said before, because then, however forgotten your previous speech may be, somebody finds out its existence, and there goes on that process so hateful to members of Parliament, which may be denoted by the term "Hansardisation." Under these circumstances, I came to the conclusion that the best thing I could do was to take the bull by the horns, and to "Hansardise" myself,— to put before you, in the briefest possible way, the three or four propositions which I endeavored to support on the occasion of the speech to which I have referred; and then to ask myself, supposing you were asking me, whether I had anything to retract. or to modify, in them, in virtue of the increased

experience, and, let us charitably hope, the increased wisdom of an added fourteen years.

Now, the points to which I directed particular attention on that occasion were these: in the first place, that instruction in physical science supplies information of a character of especial value, both in a practical and a speculative point of view — information which cannot be obtained otherwise; and, in the second place, that, as educational discipline, it supplies, in a better form than any other study can supply, exercise in a special form of logic, and a peculiar method of testing the validity of our processes of inquiry. I said further, that, even at that time, a great and increasing attention was being paid to physical science in our schools and colleges, and that, most assuredly, such attention must go on growing and increasing, until education in these matters occupied a very much larger share of the time which is given to teaching and training, than had been the case heretofore. And I threw all the strength of argumentation of which I was possessed into the support of these propositions. But I venture to remind you, also, of some other words I used at that time, and which I ask permission to read to you. They were these: "There are other forms of culture besides physical science, and I should be profoundly sorry to see the fact forgotten, or even to observe a tendency to starve or cripple literary or æsthetic culture for the sake of science. Such a narrow view of the nature of education has nothing to do with my firm conclusion that a complete and thorough scientific culture ought to be introduced into all schools."

I say I desire, in commenting upon these various points, and judging them as fairly as I can by the light of increased experience, to particularly emphasise this last, because I am told, although I assuredly do not know it of my own knowledge — though I think if the fact were so I ought to know it, being tolerably well acquainted with that which goes on in the scientific world, and which has gone on there for the last thirty years — that there is a kind of sect, or horde, of scientific Goths and Vandals, who think it would be proper and desirable to sweep away all other forms of culture and instruction, except those in physical science, and to make them the universal and exclusive, or, at any rate, the dominant training of the human mind of the future generation. This is not my view — I do not believe that it is anybody's view,— but it is attributed to those who, like myself, advocate scientific education. I therefore dwell strongly upon the point, and I beg you to believe that the words I have just now read were by no means intended by me as a sop to

the Cerberus of culture. I have not been in the habit of offering sops to any kind of Cerberus; but it was an expression of profound conviction on my own part — a conviction forced upon me not only by my mental constitution, but by the lessons of what is now becoming a somewhat long experience of varied conditions of life.

I am not about to trouble you with my autobiography; the omens are hardly favourable, at present, for work of that kind. But I should like if I may do so without appearing, what I earnestly desire not to be, egotistical,— I should like to make it clear to you, that such notions as these, which are sometimes attributed to me, are, as I have said, inconsistent with my mental constitution, and still more inconsistent with the upshot of the teaching of my experience. For I can certainly claim for myself that sort of mental temperament which can say that nothing human comes amiss to it. I have never yet met with any branch of human knowledge which I have found unattractive — which it would not have been pleasant to me to follow, so far as I could go; and I have yet to meet with any form of art in which it has not been possible for me to take as acute a pleasure as, I believe, it is possible for men to take.

And with respect to the circumstances of life, it so happens that it has been my fate to know many lands and many climates, and to be familiar, by personal experience, with almost every form of society, from the uncivilised savage of Papua and Australia and the civilised savages of the slums and dens of the poverty-stricken parts of great cities, to those who perhaps, are occasionally the somewhat over-civilised members of our upper ten thousand. And I have never found, in any of these conditions of life, a deficiency of something which was attractive. Savagery has its pleasures, I assure you, as well as civilisation, and I may even venture to confess — if you will not let a whisper of the matter get back to London, where I am known — I am even fain to confess, that sometimes in the din and throng of what is called "a brilliant reception" the vision crosses my mind of waking up from the soft plank which had afforded me satisfactory sleep during the hours of the night, in the bright dawn of a tropical morning, when my comrades were yet asleep, when every sound was hushed, except the little lap-lap of the ripples against the sides of the boat, and the distant twitter of the sea-bird on the reef. And when that vision crosses my mind, I am free to confess I desire to be back in the boat again. So that, if I share with those strange persons to whose asserted, but still hypothetical existence I have referred, the want of appreciation of forms of

culture other than the pursuit of physical science, all I can say is, that it is, in spite of my constitution, and in spite of my experience, that such should be my fate.

But now let me turn to another point, or rather to two other points, with which I propose to occupy myself. How far does the experience of the last fourteen years justify the estimate which I ventured to put forward of the value of scientific culture, and of the share — the increasing share — which it must take in ordinary education? Happily, in respect to that matter, you need not rely upon my testimony. In the last half-dozen numbers of the "Journal of Education," you will find a series of very interesting and remarkable papers, by gentlemen who are practically engaged in the business of education in our great public and other schools, telling us what is doing in these schools, and what is their experience of the results of scientific education there, so far as it has gone. I am not going to trouble you with an abstract of those papers which are well worth your study in their fulness and completeness, but I have copied out one remarkable passage, because it seems to me so entirely to bear out what I have formerly ventured to say about the value of science, both as to its subject-matter and as to the discipline which the learning of science involves. It is from a paper by Mr. Worthington — one of the masters at Clifton, the reputation of which school you know well, and at the head of which is an old friend of mine, the Rev. Mr. Wilson — to whom much credit is due for being one of the first, as I can say from my own knowledge, to take up this question and work it into practical shape. What Mr. Worthington says is this: —

"It is not easy to exaggerate the importance of the information imparted by certain branches of science; it modifies the whole criticism of life made in maturer years. The study has often, on a mass of boys, a certain influence which, I think, was hardly anticipated, and to which a good deal of value must be attached — an influence as much moral as intellectual, which is shown in the increased and increasing respect for precision of statement, and for that form of veracity which consists in the acknowledgment of difficulties. It produces a real effect to find that Nature cannot be imposed upon, and the attention given to experimental lectures, at first superficial and curious only, soon becomes minute, serious, and practical."

Ladies and gentlemen, I could not have chosen better words to express — in fact, I have, in other words, expressed the same conviction in former days — what the influence of scientific teaching, if properly carried out, must be.

But now comes the question of properly carrying it out, because, when I hear the value of school teaching in physical science disputed, my first impulse is to ask the disputer, "What have you known about it?" and he generally tells me some lamentable case of failure. Then I ask, "What are the circumstances of the case, and how was the teaching carried out?" I remember some few years ago, hearing of the head master of a large school, who had expressed great dissatisfaction with the adoption of the teaching of physical science — and that after experiment. But the experiment consisted in this — in asking one of the junior masters in the school to get up science, in order to teach it; and the young gentleman went away for a year and got up science and taught it. Well, I have no doubt that the result was as disappointing as the head-master said it was, and I have no doubt that it ought to have been as disappointing, and far more disappointing too; for, if this kind of instruction is to be of any good at all, if it is not to be less than no good, if it is to take the place of that which is already of some good, then there are several points which must be attended to.

And the first of these is the proper selection of topics, the second is practical teaching, the third is practical teachers, and the fourth is sufficiency of time. If these four points are not carefully attended to by anybody who undertakes the teaching of physical science in schools, my advice to him is, to let it alone. I will not dwell at any length upon the first point, because there is a general consensus of opinion as to the nature of the topics which should be chosen. The second point — practical teaching — is one of great importance, because it requires more capital to set it agoing, demands more time, and, last, but by no means least, it requires much more personal exertion and trouble on the part of those professing to teach, than is the case with other kinds of instruction.

When I accepted the invitation to be here this evening, your secretary was good enough to send me the addresses which have been given by distinguished persons who have previously occupied this chair. I don't know whether he had a malicious desire to alarm me; but, however that may be, I read the addresses, and derived the greatest pleasure and profit from some of them, and from none more than from the one given by the great historian, Mr. Freeman, which delighted me most of all; and, if I had not been ashamed of plagiarising, and if I had not been sure of being found out, I should have been glad to have copied very much of what Mr. Freeman said, simply putting in the word science for history. There was one notable passage,— "The difference

between good and bad teaching mainly consists in this, whether the words used are really clothed with a meaning or not." And Mr. Freeman gives a remarkable example of this. He says, when a little girl was asked where Turkey was, she answered that it was in the yard with the other fowls, and that showed she had a definite idea connected with the word Turkey, and was, so far, worthy of praise. I quite agree with that commendation; but what a curious thing it is that one should now find it necessary to urge that this is the be-all and end-all of scientific instruction — the *sine quâ non,* the absolutely necessary condition,— and yet that it was insisted upon more than two hundred years ago by one of the greatest men science ever possessed in this country, William Harvey. Harvey wrote, or at least published, only two small books, one of which is the well-known treatise on the circulation of the blood. The other, the "Exercitationes de Generatione," is less known, but not less remarkable. And not the least valuable part of it is the preface, in which there occurs this passage: "Those who, reading the words of authors, do not form sensible images of the things referred to, obtain no true ideas, but conceive false imaginations and inane phantasms." You see, William Harvey's words are just the same in substance as those of Mr. Freeman, only they happen to be rather more than two centuries older. So that what I am now saying has its application elsewhere than in science; but assuredly in science the condition of knowing, of your own knowledge, things which you talk about, is absolutely imperative.

I remember, in my youth, there were detestable books which ought to have been burned by the hands of the common hangman, for they contained questions and answers to be learned by heart, of this sort, "What is a horse? The horse is termed *Equus caballus;* belongs to the class Mammalia; order, Pachydermata; family, Solidungula." Was any human being wiser for learning that magic formula? Was he not more foolish, inasmuch as he was deluded into taking words for knowledge? It is that kind of teaching that one wants to get rid of, and banished out of science. Make it as little as you like, but, unless that which is taught is based on actual observation and familiarity with facts, it is better left alone.

There are a great many people who imagine that elementary teaching might be properly carried out by teachers provided with only elementary knowledge. Let me assure you that that is the profoundest mistake in the world. There is nothing so difficult to do as to write a good elementary book, and there is nobody so hard to teach properly and well as people who know nothing about

a subject, and I will tell you why. If I address an audience of persons who are occupied in the same line of work as myself, I can assume that they know a vast deal, and that they can find out the blunders I make. If they don't it is their fault and not mine; but when I appear before a body of people who know nothing about the matter, who take for gospel whatever I say, surely it becomes needful that I consider what I say, make sure that it will bear examination, and that I do not impose upon the credulity of those who have faith in me. In the second place, it involves that difficult process of knowing what you know so well that you can talk about it as you can talk about your ordinary business. A man can always talk about his own business. He can always make it plain; but, if his knowledge is hearsay, he is afraid to go beyond what he has recollected, and put it before those that are ignorant in such a shape that they shall comprehend it. That is why, to be a good elementary teacher, to teach the elements of any subject, requires most careful consideration, if you are a master of the subject; and, if you are not a master of it, it is needful you should familiarise yourself with so much as you are called upon to teach — soak yourself in it, so to speak — until you know it as part of your daily life and daily knowledge, and then you will be able to teach anybody. That is what I mean by practical teachers, and, although the deficiency of such teachers is being remedied to a large extent, I think it is one which has long existed, and which has existed from no fault of those who undertook to teach, but because, until the last score of years, it absolutely was not possible for any one in a great many branches of science, whatever his desire might be, to get instruction which would enable him to be a good teacher of elementary things. All that is being rapidly altered, and I hope it will soon become a thing of the past.

The last point I have referred to is the question of the sufficiency of time. And here comes the rub. The teaching of science needs time, as any other subject; but it needs more time proportionately than other subjects, for the amount of work obviously done, if the teaching is to be, as I have said, practical. Work done in a laboratory involves a good deal of expenditure of time without always an obvious result, because we do not see anything of that quiet process of soaking the facts into the mind, which takes place through the organs of the senses. On this ground there must be ample time given to science teaching. What that amount of time should be is a point which I need not discuss now; in fact, it is a point which cannot be settled until one has made up one's mind about various other questions.

All, then, that I have to ask for, on behalf of the scientific

people, if I may venture to speak for more than myself, is that you should put scientific teaching into what statesmen call the condition of "the most favoured nation"; that is to say, that it shall have as large a share of the time given to education as any other principal subject. You may say that that is a very vague statement, because the value of the allotment of time, under those circumstances, depends upon the number of principal subjects. It is x the time, and an unknown quantity of principal subjects dividing that, and science taking shares with the rest. That shows that we cannot deal with this question fully until we have made up our minds as to what the principal subjects of education ought to be.

I know quite well that launching myself into this discussion is a very dangerous operation; that it is a very large subject, and one which is difficult to deal with, however much I may trespass upon your patience in the time allotted to me. But the discussion is so fundamental, it is so completely impossible to make up one's mind on these matters until one has settled the question, that I will even venture to make the experiment. A great lawyer-statesman and philosopher of a former age — I mean Francis Bacon — said that truth came out of error much more rapidly than it came out of confusion. There is a wonderful truth in that saying. Next to being right in this world, the best of all things is to be clearly and definitely wrong, because you will come out somewhere. If you go buzzing about between right and wrong, vibrating and fluctuating, you come out nowhere; but if you are absolutely and thoroughly and persistently wrong, you must, some of these days, have the extreme good fortune of knocking your head against a fact, and that sets you all straight again. So I will not trouble myself as to whether I may be right or wrong in what I am about to say, but at any rate I hope to be clear and definite; and then you will be able to judge for yourselves whether, in following out the train of thought I have to introduce, you knock your heads against facts or not.

I take it that the whole object of education is, in the first place, to train the faculties of the young in such a manner as to give their possessors the best chance of being happy and useful in their generation; and, in the second place, to furnish them with the most important portions of that immense capitalised experience of the human race which we call knowledge of various kinds. I am using the term knowledge in its widest possible sense; and the question is, what subjects to select by training and discipline, in which the object I have just defined may be best attained.

I must call your attention further to this fact, that all the subjects of our thoughts — all feelings and propositions (leaving aside our sensations as the mere materials and occasions of thinking and feeling), all our mental furniture — may be classified under one of two heads — as either within the province of the intellect, something that can be put into propositions and affirmed or denied; or as within the province of feeling, or that which, before the name was defiled, was called the æsthetic side of our nature, and which can neither be proved nor disproved, but only felt and known.

According to the classification which I have put before you, then, the subjects of all knowledge are divisible into the two groups, matters of science and matters of art; for all things with which the reasoning faculty alone is occupied, come under the province of science; and in the broadest sense, and not in the narrow and technical sense in which we are now accustomed to use the word art, all things feelable, all things which stir our emotions, come under the term of art, in the sense of the subject-matter of the æsthetic faculty. So that we are shut up to this — that the business of education is, in the first place, to provide the young with the means and the habit of observation; and, secondly, to supply the subject-matter of knowledge either in the shape of science or of art, or of both combined.

Now, it is a very remarkable fact — but it is true of most things in this world — that there is hardly anything one-sided, or of one nature; and it is not immediately obvious what of the things that interest us may be regarded as pure science, and what may be regarded as pure art. It may be that there are some peculiarly constituted persons who, before they have advanced far into the depths of geometry, find artistic beauty about it; but, taking the generality of mankind, I think it may be said that, when they begin to learn mathematics, their whole souls are absorbed in tracing the connection between the premises and the conclusion, and that to them geometry is pure science. So I think it may be said that mechanics and osteology are pure science. On the other hand, melody in music is pure art. You cannot reason about it; there is no proposition involved in it. So, again, in the pictorial art, an arabesque, or a "harmony in grey," touches none but the æsthetic faculty. But a great mathematician, and even many persons who are not great mathematicians, will tell you that they derive immense pleasure from geometrical reasonings. Everybody knows mathematicians speak of solutions and problems as "elegant," and they tell you that a certain mass of mystic symbols is "beautiful, quite lovely." Well, you do not see it. They do

see it, because the intellectual process, the process of comprehending the reasons symbolised by these figures and these signs, confers upon them a sort of pleasure, such as an artist has in visual symmetry. Take a science of which I may speak with more confidence, and which is the most attractive of those I am concerned with. It is what we call morphology, which consists in tracing out the unity in variety of the infinitely diversified structures of animals and plants. I cannot give you any example of a thorough æsthetic pleasure more intensely real than a pleasure of this kind — the pleasure which arises in one's mind when a whole mass of different structures run into one harmony as the expression of a central law. That is where the province of art overlays and embraces the province of intellect. And, if I may venture to express an opinion on such a subject, the great majority of forms of art are not in the sense what I just now defined them to be — pure art; but they derive much of their quality from simultaneous and even unconscious excitement of the intellect.

When I was a boy, I was very fond of music, and I am so now; and it so happened that I had the opportunity of hearing much good music. Among other things, I had abundant opportunities of hearing that great old master, Sebastian Bach. I remember perfectly well — though I knew nothing about music then, and, I may add, know nothing whatever about it now — the intense satisfaction and delight which I had in listening, by the hour together, to Bach's fugues. It is a pleasure which remains with me, I am glad to think; but, of late years, I have tried to find out the why and wherefore, and it has often occurred to me that the pleasure derived from musical compositions of this kind is essentially of the same nature as that which is derived from pursuits which are commonly regarded as purely intellectual. I mean, that the source of pleasure is exactly the same as in most of my problems in morphology — that you have the theme in one of the old master's works followed out in all its endless variations, always appearing and always reminding you of unity in variety. So in painting; what is called "truth to nature" is the intellectual element coming in, and truth to nature depends entirely upon the intellectual culture of the person to whom art is addressed. If you are in Australia, you may get credit for being a good artist — I mean among the natives — if you can draw a kangaroo after a fashion. But, among men of higher civilisation, the intellectual knowledge we possess brings its criticism into our appreciation of works of art, and we are obliged to satisfy it, as well as the mere sense of beauty in colour and in outline. And so, the higher

the culture and information of those whom art addresses, the more exact and precise must be what we call its "truth to nature."

If we turn to literature, the same thing is true, and you find works of literature which may be said to be pure art. A little song of Shakespeare or of Goethe is pure art; it is exquisitely beautiful, although its intellectual content may be nothing. A series of pictures is made to pass before your mind by the meaning of words, and the effect is a melody of ideas. Nevertheless, the great mass of the literature we esteem is valued, not merely because of having artistic form, but because of its intellectual content; and the value is the higher the more precise, distinct, and true is that intellectual content. And, if you will let me for a moment speak of the very highest forms of literature, do we not regard them as highest simply because the more we know the truer they seem, and the more competent we are to appreciate beauty the more beautiful they are? No man ever understands Shakespeare until he is old, though the youngest may admire him, the reason being that he satisfies the artistic instinct of the youngest and harmonises with the ripest and richest experience of the oldest.

I have said this much to draw your attention to what, in my mind, lies at the root of all this matter, and at the understanding of one another by the men of science on the one hand, and the men of literature, and history, and art, on the other. It is not a question whether one order of study or another should predominate. It is a question of what topics of education you shall select which will combine all the needful elements in such due proportion as to give the greatest amount of food, support, and encouragement to those faculties which enable us to appreciate truth, and to profit by those sources of innocent happiness which are open to us, and, at the same time, to avoid that which is bad, and coarse, and ugly, and keep clear of the multitude of pitfalls and dangers which beset those who break through the natural or moral laws.

I address myself, in this spirit, to the consideration of the question of the value of purely literary education. Is it good and sufficient, or is it insufficient and bad? Well, here I venture to say that there are literary educations and literary educations. If I am to understand by that term the education that was current in the great majority of middle-class schools, and upper schools too, in this country when I was a boy, and which consisted absolutely and almost entirely in keeping boys for eight or ten years at learning the rules of Latin and Greek grammar, construing certain Latin and Greek authors, and possibly making

verses which, had they been English verses, would have been condemned as abominable doggerel, — if that is what you mean by liberal education, then I say it is scandalously insufficient and almost worthless. My reason for saying so is not from the point of view of science at all, but from the point of view of literature. I say the thing professes to be literary education that is not a literary education at all. It was not literature at all that was taught, but science in a very bad form. It is quite obvious that grammar is science and not literature. The analysis of a text by the help of the rules of grammar is just as much a scientific operation as the analysis of a chemical compound by the help of the rules of chemical analysis. There is nothing that appeals to the æsthetic faculty in that operation; and I ask multitudes of men of my own age, who went through this process, whether they ever had a conception of art or literature until they obtained it for themselves after leaving school? Then you may say, "If that is so, if the education was scientific, why cannot you be satisfied with it?" I say, because although it is a scientific training, it is of the most inadequate and inappropriate kind. If there is any good at all in scientific education it is that men should be trained, as I said before, to know things for themselves at first hand, and that they should understand every step of the reason of that which they do.

I desire to speak with the utmost respect of that science — philology — of which grammar is a part and parcel; yet everybody knows that grammar, as it is usually learned at school, affords no scientific training. It is taught just as you would teach the rules of chess or draughts. On the other hand, if I am to understand by a literary education the study of the literatures of either ancient or modern nations — but especially those of antiquity, and especially that of ancient Greece; if this literature is studied, not merely from the point of view of philological science, and its practical application to the interpretation of texts, but as an exemplification of and commentary upon the principles of art; if you look upon the literature of a people as a chapter in the development of the human mind, if you work out this in a broad spirit, and with such collateral references to morals and politics, and physical geography, and the like as are needful to make you comprehend what the meaning of ancient literature and civilisation is, — then, assuredly, it affords a splendid and noble education. But I still think it is susceptible of improvement, and that no man will ever comprehend the real secret of the difference between the ancient world and our present time, unless he has learned to see the difference which the late development of

physical science has made between the thought of this day and the thought of that, and he will never see that difference, unless he has some practical insight into some branches of physical science; and you must remember that a literary education such as that which I have just referred to, is out of the reach of those whose school life is cut short at sixteen or seventeen.

But, you will say, all this is fault-finding; let us hear what you have in the way of positive suggestion. Then I am bound to tell you that, if I could make a clean sweep of everything — I am very glad I cannot because I might, and probably should, make mistakes,— but if I could make a clean sweep of everything and start afresh, I should, in the first place, secure that training of the young in reading and writing, and in the habit of attention and observation, both to that which is told them, and that which they see, which everybody agrees to. But in addition to that, I should make it absolutely necessary for everybody, for a longer or shorter period, to learn to draw. Now, you may say, there are some people who cannot draw, however much they may be taught. I deny that *in toto,* because I never yet met with anybody who could not learn to write. Writing is a form of drawing; therefore if you give the same attention and trouble to drawing as you do to writing, depend upon it, there is nobody who cannot be made to draw, more or less well. Do not misapprehend me. I do not say for one moment you would make an artistic draughtsman. Artists are not made; they grow. You may improve the natural faculty in that direction, but you cannot make it; but you can teach simple drawing, and you will find it an implement of learning of extreme value. I do not think its value can be exaggerated, because it gives you the means of training the young in attention and accuracy, which are the two things in which all mankind are more deficient than in any other mental quality whatever. The whole of my life has been spent in trying to give my proper attention to things and to be accurate, and I have not succeeded as well as I could wish; and other people, I am afraid, are not much more fortunate. You cannot begin this habit too early, and I consider there is nothing of so great a value as the habit of drawing, to secure those two desirable ends.

Then we come to the subject-matter, whether scientific or æsthetic, of education, and I should naturally have no question at all about teaching the elements of physical science of the kind I have sketched, in a practical manner; but among scientific topics, using the word scientific in the broadest sense, I would also include the elements of the theory of morals and of that of

political and social life, which, strangely enough, it never seems to occur to anybody to teach a child. I would have the history of our own country, and of all the influences which have been brought to bear upon it, with incidental geography, not as a mere chronicle of reigns and battles, but as a chapter in the development of the race, and the history of civilisation.

Then with respect to æsthetic knowledge and discipline, we have happily in the English language one of the most magnificent storehouses of artistic beauty and of models of literary excellence which exists in the world at the present time. I have said before, and I repeat it here, that if a man cannot get literary culture of the highest kind out of his Bible, and Chaucer, and Shakespeare, and Milton, and Hobbes, and Bishop Berkeley, to mention only a few of our illustrious writers — I say, if he cannot get it out of those writers, he cannot get it out of anything; and I would assuredly devote a very large portion of the time of every English child to the careful study of the models of English writing of such varied and wonderful kind as we possess, and, what is still more important and still more neglected, the habit of using that language with precision, with force, and with art. I fancy we are almost the only nation in the world who seem to think that composition comes by nature. The French attend to their own language, the Germans study theirs; but Englishmen do not seem to think it is worth their while. Nor would I fail to include, in the course of study I am sketching, translations of all the best works of antiquity, or of the modern world. It is a very desirable thing to read Homer in Greek; but if you don't happen to know Greek, the next best thing we can do is to read as good a translation of it as we have recently been furnished with in prose. You won't get all you would get from the original, but you may get a great deal; and to refuse to know this great deal because you cannot get all, seems to be as sensible as for a hungry man to refuse bread because he cannot get partridge. Finally, I would add instruction in either music or painting, or, if the child should be so unhappy, as sometimes happens, as to have no faculty for either of those, and no possibility of doing anything in any artistic sense with them, then I would see what could be done with literature alone; but I would provide, in the fullest sense, for the development of the æsthetic side of the mind. In my judgment, those are all the essentials of education for an English child. With that outfit, such as it might be made in the time given to education which is within the reach of nine-tenths of the population — with that outfit, an Englishman, within the limits of English life, is fitted to go anywhere, to occupy the

highest positions, to fill the highest offices of the State, and to become distinguished in practical pursuits, in science, or in art. For, if he have the opportunity to learn all those things, and have his mind disciplined in the various directions the teaching of those topics would have necessitated, then, assuredly, he will be able to pick up, on his road through life, all the rest of the intellectual baggage he wants.

If the educational time at our disposition were sufficient there are one or two things I would add to those I have just now called the essentials; and perhaps you will be surprised to hear, though I hope you will not, that I should add, not more science, but one, or, if possible, two languages. The knowledge of some other language than one's own is, in fact, of singular intellectual value. Many of the faults and mistakes of the ancient philosophers are traceable to the fact that they knew no language but their own, and were often led into confusing the symbol with the thought which it embodied. I think it is Locke who says that one-half of the mistakes of philosophers have arisen from questions about words; and one of the safest ways of delivering yourself from the bondage of words is, to know how ideas look in words to which you are not accustomed. That is one reason for the study of language; another reason is, that it opens new fields in art and in science. Another is the practical value of such knowledge; and yet another is this, that if your languages are properly chosen, from the time of learning the additional languages you will know your own language better than ever you did. So, I say, if the time given to education permits, add Latin and German. Latin, because it is the key to nearly one-half of English and to all the Romance languages; and German, because it is the key to almost all the remainder of English, and helps you to understand a race from whom most of us have sprung, and who have a character and a literature of a fateful force in the history of the world, such as probably has been allotted to those of no other people, except the Jews, the Greeks, and ourselves. Beyond these, the essential and the eminently desirable elements of all education, let each man take up his special line — the historian devote himself to his history, the man of science to his science, the man of letters to his culture of that kind, and the artist to his special pursuit.

Bacon has prefaced some of his works with no more than this: *Franciscus Bacon sic cogitavit;* let "sic cogitavi" be the epilogue to what I have ventured to address to you to-night.

VIII.

UNIVERSITIES: ACTUAL AND IDEAL.

ELECTED by the suffrages of your four Nations Rector of the ancient University of which you are scholars, I take the earliest opportunity which has presented itself since my restoration to health, of delivering the Address which, by long custom, is expected of the holder of my office.

My first duty in opening that Address, is to offer you my most hearty thanks for the signal honour you have conferred upon me — an honour of which, as a man unconnected with you by personal or by national ties, devoid of political distinction, and a plebeian who stands by his order, I could not have dreamed. And it was the more surprising to me, as the five-and-twenty years which have passed over my head since I reached intellectual manhood, have been largely spent in no half-hearted advocacy of doctrines which have not yet found favour in the eyes of Academic respectability; so that, when the proposal to nominate me for your Rector came, I was almost as much astonished as was Hal o' the Wynd, "who fought for his own hand," by the Black Douglas's proffer of knighthood. And I fear that my acceptance must be taken as evidence that, less wise than the Armourer of Perth, I have not yet done with soldiering.

In fact, if, for a moment, I imagined that your intention was simply, in the kindness of your hearts, to do me honour; and that the rector of your University, like that of some other Universities, was one of those happy beings who sit in glory for three years, with nothing to do for it save the making of a speech, a conversation with my distinguished predecessor soon dispelled the dream. I found that, by the constitution of the University of Aberdeen, the incumbent of the Rectorate is, if not a power, at any rate a potential energy; and that, whatever may be his chances of success or failure, it is his duty to convert that potential energy into a living force, directed towards such ends as may seem to him conducive to the welfare of the corporation of which he is the theoretical head.

I need not tell you that your late Lord Rector took this view of his position, and acted upon it with the comprehensive, far-seeing insight into the actual condition and tendencies, not merely of his own, but of other countries, which is his honourable characteristic among statesmen. I have already done my best, and, as long as I hold my office, I shall continue my endeavours, to follow in the path which he trod; to do what in me lies, to bring this University nearer to the ideal — alas, that I should be obliged to say ideal — of all Universities; which, as I conceive, should be places in which thought is free from all fetters; and in which all sources of knowledge, and all aids to learning, should be accessible to all comers, without distinction of creed or country, riches or poverty.

Do not suppose, however, that I am sanguine enough to expect much to come of any poor efforts of mine. If your annals take any notice of my incumbency, I shall probably go down to posterity as the Rector who was always beaten. But if they add, as I think they will, that my defeats became victories in the hands of my successors, I shall be well content.

The scenes are shifting in the great theatre of the world. The act which commenced with the Protestant Reformation is nearly played out, and a wider and deeper change than that effected three centuries ago — a reformation, or rather a revolution of thought, the extremes of which are represented by the intellectual heirs of John of Leyden and of Ignatius Loyola, rather than by those of Luther and of Leo — is waiting to come on, nay, visible behind the scenes to those who have good eyes. Men are beginning, once more, to awake to the fact that matters of belief and of speculation are of absolutely infinite practical importance; and are drawing off from that sunny country "where it is always afternoon" — the sleepy hollow of broad indifferentism — to range themselves under their natural banners. Change is in the air. It is whirling feather-heads into all sorts of eccentric orbits, and filling the steadiest with a sense of insecurity. It insists on reopening all questions and asking all institutions, however venerable, by what right they exist, and whether they are, or are not, in harmony with the real or supposed wants of mankind. And it is remarkable that these searching inquiries are not so much forced on institutions from without, as developed from within. Consummate scholars question the value of learning; priests contemn dogma; and women turn their backs upon man's ideal of perfect womanhood, and seek satisfaction in apocalyptic visions of some, as yet, unrealised epicene reality.

If there be a type of stability in this world, one would be inclined to look for it in the old Universities of England. But it has been my business of late to hear a good deal about what is going on in these famous corporations; and I have been filled with astonishment by the evidences of internal fermentation which they exhibit. If Gibbon could revisit the ancient seat of learning of which he has written so cavalierly, assuredly he would no longer speak of "the monks of Oxford sunk in prejudice and port." There, as elsewhere, port has gone out of fashion, and so has prejudice — at least that particular fine, old, crusted sort of prejudice to which the great historian alludes.

Indeed, things are moving so fast in Oxford and Cambridge, that, for my part, I rejoiced when the Royal Commission, of which I am a member, had finished and presented the Report which related to these Universities; for we should have looked like mere plagiarists, if, in consequence of a little longer delay in issuing it, all the measures of reform we proposed had been anticipated by the spontaneous action of the Universities themselves.

A month ago I should have gone on to say that one might speedily expect changes of another kind in Oxford and Cambridge. A Commission has been inquiring into the revenues of the many wealthy societies in more or less direct connection with the Universities, resident in those towns. It is said that the Commission has reported, and that, for the first time in recorded history, the nation, and perhaps the Colleges themselves, will know what they are worth. And it was announced that a statesman, who, whatever his other merits or defects, has aims above the level of mere party fighting, and a clear vision into the most complex practical problems, meant to deal with these revenues.

But, *Bos locutus est.* That mysterious independent variable of political calculation, Public Opinion — which some whisper is, in the present case, very much the same thing as publican's opinion — has willed otherwise. The Heads may return to their wonted slumbers — at any rate for a space.

Is the spirit of change, which is working thus vigorously in the South, likely to affect the Northern Universities, and if so, to what extent? The violence of fermentation depends, not so much on the quantity of the yeast, as on the composition of the wort, and its richness in fermentable material; and, as a preliminary to the discussion of this question, I venture to call to your minds the essential and fundamental differences between the Scottish and the English type of University.

Do not charge me with anything worse than official egotism, if

I say that these differences appear to be largely symbolised by my own existence. There is no Rector in an English University. Now, the organisation of the members of a University into Nations, with their elective Rector, is the last relic of the primitive constitution of Universities. The Rectorate was the most important of all offices in that University of Paris, upon the model of which the University of Aberdeen was fashioned; and which was certainly a great and flourishing institution in the twelfth century.

Enthusiasts for the antiquity of one of the two acknowledged parents of all Universities, indeed, do not hesitate to trace the origin of the "Studium Parisiense" up to that wonderful king of the Franks and Lombards, Karl, surnamed the Great, whom we all called Charlemagne, and believed to be a Frenchman, until a learned historian, by beneficent iteration, taught us better. Karl is said not to have been much of a scholar himself, but he had the wisdom of which knowledge is only the servitor. And that wisdom enabled him to see that ignorance is one of the roots of all evil.

In the Capitulary which enjoins the foundation of monasterial and cathedral schools, he says: "Right action is better than knowledge; but in order to do what is right, we must know what is right."* An irrefragable truth, I fancy. Acting upon it, the king took pretty full compulsory powers, and carried into effect a really considerable and effectual scheme of elementary education through the length and breadth of his dominions.

No doubt the idolaters out by the Elbe, in what is now part of Prussia, objected to the Frankish king's measures; no doubt the priests, who had never hesitated about sacrificing all unbelievers in their fantastic deities and futile conjurations, were the loudest in chanting the virtues of toleration; no doubt they denounced as a cruel persecutor the man who would not allow them, however sincere they might be, to go on spreading delusions which debased the intellect, as much as they deadened the moral sense, and undermined the bonds of civil allegiance; no doubt, if they had lived in these times, they would have been able to show, with ease, that the king's proceedings were totally contrary to the best liberal principles. But it may be said, in justification of the Teutonic ruler, first, that he was born before those principles, and did not suspect that the best way of getting disorder into order was to let it alone; and, secondly, that his

* "Quamvis enim melius sit bene facere quam nosse, prius tamen est nosse quam facere."—"Karoli Magni Regis Constitutio de Scholis per singula Episcopia et Monasteria instituendis," addressed to the Abbot of Fulda. Baluzius, *Captitularia Regum Francorum*, T. i., p. 202.

rough and questionable proceedings did, more or less, bring about the end he had in view. For, in a couple of centuries, the schools he sowed broadcast produced their crop of men, thirsting for knowledge and craving for culture. Such men gravitating towards Paris, as a light amidst the darkness of evil days, from Germany, from Spain, from Britain, and from Scandinavia, came together by natural affinity. By degrees they banded themselves into a society, which, as its end was the knowledge of all things knowable, called itself a "*Studium Generale*," and when it had grown into a recognised corporation, acquired the name of "*Universitas Studii Generalis*," which, mark you, means not a "Useful Knowledge Society," but a "Knowledge-of-things-in-general Society."

And thus the first "University," at any rate on this side of the Alps, came into being. Originally it had but one Faculty, that of Arts. Its aim was to be a centre of knowledge and culture; not to be, in any sense, a technical school.

The scholars seem to have studied Grammar, Logic, and Rhetoric; Arithmetic and Geometry; Astronomy; Theology; and Music. Thus, their work, however imperfect and faulty, judged by modern lights, it may have been, brought them face to face with all the leading aspects of the many-sided mind of man. For these studies did really contain, at any rate in embyro — sometimes, it may be, in caricature — what we now call Philosophy, Mathematical and Physical Science, and Art. And I doubt if the curriculum of any modern University shows so clear and generous a comprehension of what is meant by culture, as this old Trivium and Quadrivium does.

The students who had passed through the University course, and had proved themselves competent to teach, became masters and teachers of their younger brethren. Whence the distinction of Masters and Regents on the one hand, and Scholars on the other.

Rapid growth necessitated organisation. The Masters and Scholars of various tongues and countries grouped themselves into four Nations; and the Nations, by their own votes at first, and subsequently by those of their Procurators, or representatives, elected their supreme head and governor, the Rector — at that time the sole representative of the University, and a very real power, who could defy Provosts interfering from without; or could inflict even corporal punishment on disobedient members within the University.

Such was the primitive constitution of the University of Paris. It is in reference to this original state of things that I have

spoken of the Rectorate, and all that appertains to it, as the sole relic of that constitution.

But this original organisation did not last long. Society was not then, any more than it is now, patient of culture, as such. It says to everything, "Be useful to me, or away with you." And to the learned, the unlearned man said then, as he does now, "What is the use of all your learning, unless you can tell me what I want to know? I am here blindly groping about, and constantly damaging myself by collision with three mighty powers, the power of the invisible God, the power of my fellow Man, and the power of brute Nature. Let your learning be turned to the study of these powers, that I may know how I am to comport myself with regard to them." In answer to this demand, some of the Masters of the Faculty of Arts devoted themselves to the study of Theology, some to that of Law, and some to that of Medicine; and they became Doctors — men learned in those technical, or, as we now call them, professional, branches of knowledge. Like cleaving to like, the Doctors formed schools, or Faculties, of Theology, Law, and Medicine, which sometimes assumed airs of superiority over their parent, the Faculty of Arts, though the latter always asserted and maintained its fundamental supremacy.

The Faculties arose by process of natural differentiation out of the primitive University. Other constituents, foreign to its nature, were speedily grafted upon it. One of these extraneous elements were forced into it by the Roman Church, which in those days asserted with effect, that which it now asserts, happily without any effect in these realms, its rights of censorship and control over all teaching. The local habitation of the University lay partly in the lands attached to the monastery of S. Geneviève, partly in the diocese of the Bishop of Paris; and he who would teach must have the license of the Abbot, or of the Bishop, as the nearest representative of the Pope, so to do, which license was granted by the Chancellors of these Ecclesiastics.

Thus, if I am what archæologists call a "survival" of the primitive head and ruler of the University, your Chancellor stands in the same relation to the Papacy; and, with all respect for his Grace, I think I may say that we both look terribly shrunken when compared with our great originals.

Not so is it with the second foreign element, which silently dropped into the soil of Universities, like the grain of mustard-seed in the parable; and, like that grain, grew into a tree, in whose branches a whole aviary of fowls took shelter. That element is the element of Endowment. It differed from the preceding, in its original design to serve as a prop to the young plant, not to be a parasite upon it. The charitable and the hu-

mane, blessed with wealth, were very early penetrated by the misery of the poor student. And the wise saw that intellectual ability is not so common or so unimportant a gift that it should be allowed to run to waste upon mere handicrafts and chares.* The man who was a blessing to his contemporaries, but who so often has been converted into a curse, by the blind adherence of his posterity to the letter, rather than to the spirit, of his wishes —I mean the "pious founder"— gave money and lands, that the student, who was rich in brain and poor in all else, might be taken from the plough or from the smithy, and enabled to devote himself to the higher service of mankind; and built colleges and halls in which he might be not only housed and fed, but taught.

The Colleges were very generally placed in strict subordination to the University by their founders; but, in many cases, their endowment, consisting of land, has undergone an "unearned increment," which has given these societies a continually increasing weight and importance as against the unendowed, or fixedly endowed, University. In Pharaoh's dream, the seven lean kine eat up the seven fat ones. In the reality of historical fact, the fat Colleges have eaten up the lean Universities.

Even here in Aberdeen, though the causes at work may have been somewhat different, the effects have been similar; and you see how much more substantial an entity is the Very Reverend the Principal, analogue, if not homologue, of the Principals of King's College, than the Rector, lineal representative of the ancient monarchs of the University, though now, little more than a "king of shreds and patches."

Do not suppose that, in thus briefly tracing the process of University metamorphosis, I have had any intention of quarrelling with its results. Practically, it seems to me that the broad changes effected in 1858 have given the Scottish Universities a very liberal constitution, with as much real approximation to the primitive state of things as is at all desirable. If your fat kine have eaten the lean, they have not lain down to chew the cud ever since. The Scottish Universities, like the English, have diverged widely enough from their primitive model; but I cannot help thinking that the northern form has remained more faithful to its original, not only in constitution, but, what is more to the purpose, in view of the cry for change, in the practical application of the endowments connected with it.

In Aberdeen, these endowments are numerous, but so small that, taken altogether, they are not equal to the revenue of a single third-rate English college. They are scholarships, not fel-

* Old English for "chores."

lowships; aids to do work — not rewards for such work as it lies within the reach of an ordinary, or even an extraordinary, young man to do. You do not think that passing a respectable examination is a fair equivalent for an income, such as many a grey-headed veteran, or clergyman would envy; and which is larger than the endowment of many Regius chairs. You do not care to make your University a school of manners for the rich; of sports for the athletic; or a hot-bed of high-fed, hypercritical refinement, more destructive to vigour and originality than are starvation and oppression. No; your little Bursaries of ten and twenty (I believe even fifty) pounds a year, enabled any boy who has shown ability in the course of his education in those remarkable primary schools, which have made Scotland the power she is, to obtain the highest culture the country can give him; and when he is armed and equipped, his Spartan Alma Mater tells him that, so far, he has had his wages for his work, and that he may go and earn the rest.

When I think of the host of pleasant, moneyed, well-bred young gentlemen, who do a little learning and much boating by Cam and Isis, the vision is a pleasant one; and, as a patriot, I rejoice that the youth of the upper and richer classes of the nation receive a wholesome and a manly training, however small may be the modicum of knowledge they gather, in the intervals of this, their serious business. I admit, to the full, the social and political value of that training. But, when I proceed to consider that these young men may be said to represent the great bulk of what the Colleges have to show for their enormous wealth, plus, at least, a hundred and fifty pounds a year apiece which each undergraduate costs his parents or guardians, I feel inclined to ask, whether the rate-in-aid of the education of the wealthy and professional classes, thus levied on the resources of the community, is not, after all, a little heavy? And, still further, I am tempted to inquire what has become of the indigent scholars, the sons of the masses of the people whose daily labour just suffices to meet their daily wants, for whose benefit these rich foundations were largely, if not mainly, instituted? It seems as if Pharaoh's dream had been rigorously carried out, and that even the fat scholar has eaten the lean one. And when I turn from this picture to the no less real vision of many a brave and frugal Scotch boy, spending his summer in hard manual labour, that he may have the privilege of wending his way in autumn to this University, with a bag of oatmeal, ten pounds in his pocket, and his own stout heart to depend upon through the northern winter; not bent on seeking

"The bubble reputation at the cannon's mouth,"

but determined to wring knowledge from the hard hands of penury; when I see him win through all such outward obstacles to positions of wide usefulness and well-earned fame; I cannot but think that, in essence, Aberdeen has departed but little from the primitive intention of the founders of Universities, and that the spirit of reform has so much to do on the other side of the Border, that it may be long before he has leisure to look this way.

As compared with other actual Universities, then, Aberdeen, may, perhaps, be well satisfied with itself. But do not think me an impracticable dreamer, if I ask you not to rest and be thankful in this state of satisfaction; if I ask you to consider awhile, how this actual good stands related to that ideal better, towards which both men and institutions must progress, if they would not retrograde.

In an ideal University, as I conceive it, a man should be able to obtain instruction in all forms of knowledge and discipline in the use of all the methods by which knowledge is obtained. In such a University, the force of living example should fire the student with a noble ambition to emulate the learning of learned men, and to follow in the footsteps of the explorers of new fields of knowledge. And the very air he breathes should be charged with that enthusiasm for truth, that fanaticism of veracity, which is a greater possession than much learning; a nobler gift than the power of increasing knowledge; by so much greater and nobler than these, as the moral nature of man is greater than the intellectual; for veracity is the heart of morality.

But the man who is all morality and intellect, although he may be good and even great, is, after all, only half a man. There is beauty in the moral world and in the intellectual world; but there is also a beauty which is neither moral nor intellectual — the beauty of the world of Art. There are men who are devoid of the power of seeing it, as there are men who are born deaf and blind, and the loss of those, as of these, is simply infinite. There are others in whom it is an overpowering passion; happy men, born with the productive, or at lowest, the appreciative, genius of the Artist. But, in the mass of mankind, the Æsthetic faculty, like the reasoning power and the moral sense, needs to be roused, directed, and cultivated; and I know not why the development of that side of his nature, through which man has access to a perennial spring of ennobling pleasure, should be omitted from any comprehensive scheme of University education.

All Universities recognise Literature in the sense of the old Rhetoric, which is art incarnate in words. Some, to their credit,

recognize Art in its narrower sense, to a certain extent, and confer degrees for proficiency in some of its branches. If there are Doctors of Music, why should there be no Masters of painting, of Sculpture, of Architecture? I should like to see Professors of the Fine Arts in every University; and instruction in some branch of their work made a part of the Arts curriculum.

I just now expressed the opinion that, in our ideal University, a man should be able to obtain instruction in all forms of knowledge. Now, by "forms of knowledge," I mean the great classes of things knowable; of which the first, in logical, though not in natural, order is knowledge relating to the scope and limits of the mental faculties of man, a form of knowledge which, in its positive aspect, answers pretty much to Logic and part of Psychology, while, on its negative and critical side, it corresponds with Metaphysics.

A second class comprehends all that knowledge which relates to man's welfare, so far as it is determined by his own acts, or what we call his conduct. It answers to Moral and Religious philosophy. Practically, it is the most directly valuable of all forms of knowledge, but speculatively, it is limited and criticised by that which precedes and by that which follows it in my order of enumeration.

A third class embraces knowledge of the phænomena of the Universe, as that which lies about the individual man; and of the rules which those phænomena are observed to follow in the order of their occurrence, which we term the laws of Nature.

That is what ought to be called Natural Science, or Physiology, though those terms are hopelessly diverted from such a meaning; and it includes all exact knowledge of natural fact, whether Mathematical, Physical, Biological, or Social.

Kant has said that the ultimate object of all knowledge is to give replies to these three questions: What can I do? What ought I to do? What may I hope for? The forms of knowledge which I have enumerated, should furnish such replies as are within human reach, to the first and second of these questions. While to the third, perhaps the wisest answer is, "Do what you can to do what you ought, and leave hoping and fearing alone."

If this be a just and an exhaustive classification of the forms of knowledge, no question as to their relative importance, or as to their superiority of one to the other, can be seriously raised.

On the face of the matter, it is absurd to ask whether it is more important to know the limits of one's powers; or the ends for which they ought to be exerted; or the conditions under which they must be exerted. One may as well inquire which of the

terms of a Rule of Three sum one ought to know, in order to get a trustworthy result. Practical life is such a sum, in which your duty multiplies into your capacity, and divided by your circumstances, gives you the fourth term in the proportion, which is your deserts, with great accuracy. All agree, I take it, that men ought to have these three kinds of knowledge. The so-called "conflict of studies" turns upon the question of how they may be best obtained.

The founders of Universities held the theory that the Scriptures and Aristotle taken together, the latter being limited by the former, contained all knowledge worth having, and that the business of philosophy was to interpret and co-ordinate these two. I imagine that in the twelfth century this was a very fair conclusion from known facts. Nowhere in the world, in those days, was there such an encyclopædia of knowledge of all three classes, as is to be found in those writings. The scholastic philosophy is a wonderful monument of the patience and ingenuity with which the human mind toiled to build up a logically consistent theory of the Universe, out of such materials. And that philosophy is by no means dead and buried, as many vainly suppose. On the contrary, numbers of men of no mean learning and accomplishment, and sometimes of rare power and subtlety of thought, hold by it as the best theory of things which has yet been stated. And, what is still more remarkable, men who speak the language of modern philosophy, nevertheless think the thoughts of the schoolmen. "The voice is the voice of Jacob, but the hands are the hands of Esau." Every day I hear "Cause," "Law," "Force," "Vitality," spoken of as entities, by people who can enjoy Swift's joke about the meat-roasting quality of the smoke-jack, and comfort themselves with the reflection that they are not even as those benighted schoolmen.

Well, this great system had its day, and then it was sapped and mined by two influences. The first was the study of classical literature, which familiarised men with methods of philosophising; with conceptions of the highest Good; with ideas of the order of Nature; with notions of Literary and Historical Criticism; and, above all, with visions of Art, of a kind which not only would not fit into the scholastic scheme, but showed them a pre-Christian, and indeed altogether un-Christian world, of such grandeur and beauty that they ceased to think of any other. They were as men who had kissed the Fairy Queen, and wandering with her in the dim loveliness of the under-world, cared not to return to the familiar ways of home and fatherland, though they lay, at arm's length, overhead. Cardinals were more familiar with Virgil than

with Isaiah; and Popes laboured, with great success, to re-paganise Rome.

The second influence was the slow, but sure, growth of the physical sciences. It was discovered that some results of speculative thought, of immense practical and theoretical importance, can be verified by observation; and are always true, however severely they may be tested. Here, at any rate, was knowledge, to the certainty of which no authority could add, or take away, one jot or tittle, and to which the tradition of a thousand years was as insignificant as the hearsay of yesterday. To the scholastic system, the study of classical literature might be inconvenient and distracting, but it was possible to hope that it could be kept within bounds. Physical science, on the other hand, was an irreconcilable enemy, to be excluded at all hazards. The College of Cardinals has not distinguished itself in Physics or Physiology; and no Pope has, as yet, set up public laboratories in the Vatican.

People do not always formulate the beliefs on which they act. The instinct of fear and dislike is quicker than the reasoning process; and I suspect that, taken in conjunction with some other causes, such instinctive aversion is at the bottom of the long exclusion of any serious discipline in the physical sciences from the general curriculum of Universities; while, on the other hand, classical literature has been gradually made the backbone of the Arts course.

I am ashamed to repeat here what I have said elsewhere, in season and out of season, respecting the value of Science as knowledge and discipline. But the other day I met with some passages in the Address to another Scottish University, of a great thinker, recently lost to us, which express so fully, and yet so tersely, the truth in this matter that I am fain to quote them:—

"To question all things;—never to turn away from any difficulty; to accept no doctrine either from ourselves or from other people without a rigid scrutiny by negative criticism; letting no fallacy, or incoherence, or confusion of thought, step by unperceived; above all, to insist upon having the meaning of a word clearly understood before using it, and the meaning of a proposition before assenting to it;—these are the lessons we learn" from workers in Science. "With all this vigorous management of the negative element, they inspire no scepticism about the reality of truth or indifference to its pursuit. The noblest enthusiasm, both for the search after truth and for applying it to its highest uses, pervades those writers." "In cultivating, therefore," science as an essential ingredient in education, "we are all the

while laying an admirable foundation for ethical and philosophical culture."*

The passages I have quoted were uttered by John Stuart Mill; but you cannot hear inverted commas, and it is therefore right that I should add, without delay, that I have taken the liberty of substituting "workers in science" for "ancient dialecticians," and "Science as an essential ingredient in education" for "the ancient languages as our best literary education." Mill did, in fact, deliver a noble panegyric upon classical studies. I do not doubt its justice, nor presume to question its wisdom. But I venture to maintain that no wise or just judge, who has a knowledge of the facts, will hesitate to say that it applies with equal force to scientific training.

But it is only fair to the Scottish Universities to point out that they have long understood the value of Science as a branch of general education. I observe, with the greatest satisfaction, that candidates for the degree of Master of Arts in this University are required to have a knowledge, not only of Mental and Moral Philosophy, and of Mathematics and Natural Philosophy, but of Natural History, in addition to the ordinary Latin and Greek course; and that a candidate may take honours in these subjects and in Chemistry.

I do not know what the requirements of your examiners may be, but I sincerely trust that they are not satisfied with a mere book knowledge of these matters. For my own part I would not raise a finger, if I could thereby introduce mere book work in science into every Arts curriculum in the country. Let those who want to study books devote themselves to Literature, in which we have the perfection of books, both as to substance and as to form. If I may paraphrase Hobbes's well-known aphorism, I would say that "books are the money of Literature, but only the counters of Science," Science (in the sense in which I now use the term) being the knowledge of fact, of which every verbal description is but an incomplete and symbolic expression. And be assured that no teaching of science is worth anything, as a mental discipline, which is not based upon direct perception of the facts, and practical exercise of the observing and logical faculties upon them. Even in such a simple matter as the mere comprehension of form, ask the most practised and widely informed anatomist what is the difference between his knowledge of a structure which he has read about, and his knowledge of the same structure when he has seen it for himself; and he will tell

* Inaugural Address delivered to the University of St. Andrew, by J. S. Mill, Rector of the University (pp. 32, 33).

you that the two things are not comparable — the difference is infinite. Thus I am very strongly inclined to agree with some learned schoolmasters who say that, in their experience, the teaching of science is all waste time. As they teach it, I have no doubt it is. But to teach it otherwise requires an amount of personal labour and a development of means and appliances, which must strike horror and dismay into a man accustomed to mere book work; and who has been in the habit of teaching a class of fifty without much strain upon his energies. And this is one of the real difficulties in the way of the introduction of physical science into the ordinary University course, to which I have alluded. It is a difficulty which will not be overcome, until years of patient study have organised scientific teaching as well as, or I hope better than, classical teaching has been organised hitherto.

A little while ago, I ventured to hint a doubt as to the perfection of some of the arrangements in the ancient Universities of England; but, in their provision for giving instruction in Science as such, and without direct reference to any of its practical applications, they have set a brilliant example. Within the last twenty years, Oxford alone has sunk more than a hundred and twenty thousand pounds in building and furnishing Physical, Chemical, and Physiological Laboratories, and a magnificent Museum, arranged with an almost luxurious regard for the needs of the student. Cambridge, less rich, but aided by the munificence of her Chancellor, is taking the same course; and in a few years, it will be for no lack of the means and appliances of sound teaching, if the mass of English University men remain in their present state of barbarous ignorance of even the rudiments of scientific culture.

Yet another step needs to be made before Science can be said to have taken its proper place in the Universities. That is its recognition as a Faculty, or branch of study demanding recognition and special organisation, on account of its bearing on the wants of mankind. The faculties of Theology, Law, and Medicine, are technical schools, intended to equip men who have received general culture, with the special knowledge which is needed for the proper performance of the duties of clergymen, lawyers, and medical practitioners.

When the material well-being of the country depended upon rude pasture and agriculture, and still ruder mining; in the days when all the innumerable applications of the principles of physical science to practical purposes were non-existent even as dreams; days which men living may have heard their fathers speak of; what little physical science could be seen to bear directly upon

human life, lay within the province of Medicine. Medicine was the foster-mother of Chemistry, because it has to do with the preparation of drugs and the detection of poisons; of Botany, because it enabled the physician to recognise medicinal herbs; of Comparative Anatomy and Physiology, because the man who studied Human Anatomy and Physiology for purely medical purposes was led to extend his studies to the rest of the animal world.

Within my recollection, the only way in which a student could obtain anything like a training in Physical Science, was by attending the lectures of the Professors of Physical and Natural Science attached to the Medical Schools. But, in the course of the last thirty years, both foster-mother and child have grown so big, that they threaten not only to crush one another, but to press the very life out of the unhappy student who enters the nursery; to the great detriment of all three.

I speak in the presence of those who know practically what medical education is; for I may assume that a large proportion of my hearers are more or less advanced students of medicine. I appeal to the most industrious and conscientious among you, to those who are most deeply penetrated with a sense of the extremely serious responsibilities which attach to the calling of a medical practitioner, when I ask whether, out of the four years which you devote to your studies, you ought to spare even so much as an hour for any work which does not tend directly to fit you for your duties?

Consider what that work is. Its foundation is a sound and practical acquaintance with the structure of the human organism, and with the modes and conditions of its action in health. I say a sound and practical acquaintance, to guard against the supposition that my intention is to suggest that you ought all to be minute anatomists and accomplished physiologists. The devotion of your whole four years to Anatomy and Physiology alone, would be totally insufficient to attain that end. What I mean is, the sort of practical, familiar, finger-end knowledge which a watchmaker has of a watch, and which you expect that craftsman, as an honest man, to have, when you entrust a watch that goes badly, to him. It is a kind of knowledge which is to be acquired, not in the lecture-room, nor in the library, but in the dissecting-room and the laboratory. It is to be had not by sharing your attention between these and sundry other subjects, but by concentrating your minds, week after week, and month after month, six or seven hours a day, upon all the complexities of organ and function, until each of the greater truths of anatomy and physiology has become an organic part of your minds — until you would know

them if you were roused and questioned in the middle of the night, as a man knows the geography of his native place and the daily life of his home. That is the sort of knowledge which, once obtained, is a life-long possession. Other occupations may fill your minds — it may grow dim, and seem to be forgotten — but there it is, like the inscription on a battered and defaced coin, which comes out when you warm it.

If I had the power to remodel Medical Education, the first two years of the medical curriculum should be devoted to nothing but such thorough study of Anatomy and Physiology, with Physiological Chemistry and Physics; the student should then pass a real, practical examination in these subjects; and, having gone through the ordeal satisfactorily, he should be troubled no more with them. His whole mind should then be given with equal intentness to Therapeutics, in its broadest sense, to Practical Medicine and to Surgery, with instruction in Hygiene and in Medical Jurisprudence; and of these subjects only — surely there are enough of them — should he be required to show a knowledge in his final examination.

I cannot claim any special property in this theory of what the medical curriculum should be, for I find that views, more or less closely approximating these, are held by all who have seriously considered the very grave and pressing question of Medical Reform; and have, indeed, been carried into practice, to some extent, by the most enlightened Examining Boards. I have heard but two kinds of objections to them. There is first, the objection of vested interests, which I will not deal with here, because I want to make myself as pleasant as I can, and no discussions are so unpleasant as those which turn on such points. And there is, secondly, the much more respectable objection, which takes the general form of the reproach that, in thus limiting the curriculum, we are seeking to narrow it. We are told that the medical man ought to be a person of good education and general information, if his profession is to hold its own among other professions; that he ought to know Botany, or else, if he goes abroad, he will not be able to tell poisonous fruits from edible ones; that he ought to know drugs, as a druggist knows them, or he will not be able to tell sham bark and senna from the real articles; that he ought to know Zoology, because — well, I really have never been able to learn exactly why he is to be expected to know zoology. There is, indeed, a popular superstition, that doctors know all about things that are queer or nasty to the general mind, and may, therefore, be reasonably expected to know the "barbarous binomials" applicable to snakes, snails, and slugs; an amount of infor-

mation with which the general mind is usually completely satisfied. And there is a scientific superstition that Physiology is largely aided by Comparative Anatomy — a superstition which, like most superstitions, once had a grain of truth at bottom; but the grain has become homœopathic, since Physiology took its modern experimental development, and became what it is now, the application of the principles of Physics and Chemistry to the elucidation of the phænomena of life.

I hold as strongly as any one can do, that the medical practitioner ought to be a person of education and good general culture; but I also hold by the old theory of a Faculty, that a man should have his general culture before he devotes himself to the special studies of that Faculty; and I venture to maintain, that, if the general culture obtained in the Faculty of Arts were what it ought to be, the student would have quite as much knowledge of the fundamental principles of Physics, of Chemistry, and of Biology, as he needs, before he commenced his special medical studies.

Moreover, I would urge, that a thorough study of Human Physiology is, in itself, an education broader and more comprehensive than much that passes under that name. There is no side of the intellect which it does not call into play, no region of human knowledge into which either its roots, or its branches, do not extend; like the Atlantic between the Old and the New Worlds, its waves wash the shores of the two worlds of matter and of mind; its tributary streams flow from both; through its waters, as yet unfurrowed by the keel of any Columbus, lies the road, if such there be, from the one to the other; far away from that North-west Passage of mere speculation, in which so many brave souls have been hopelessly frozen up.

But whether I am right or wrong about all this, the patent fact of the limitation of time remains. As the song runs: —

> "If a man could be sure
> That his life would endure
> For the space of a thousand long years——"

he might do a number of things not practicable under present conditions. Methuselah might, with much propriety, have taken half a century to get his doctor's degree; and might, very fairly, have been required to pass a practical examination upon the contents of the British Museum, before commencing practice as a promising young fellow of two hundred, or thereabouts. But you have four years to do your work in, and are turned loose, to save or slay, at two or three and twenty.

Now, I put it to you, whether you think that, when you come down to the realities of life — when you stand by the sick-bed, racking your brains for the principles which shall furnish you with the means of interpreting symptoms, and forming a rational theory of the condition of your patient, it will be satisfactory for you to find that those principles are not there — although, to use the examination slang which is unfortunately too familiar to me, you can quite easily "give an account of the leading peculiarities of the *Marsupialia*," or "enumerate the chief characters of the *Compositæ*," or "state the class and order of the animal from which Castoreum is obtained."

I really do not think that state of things will be satisfactory to you; I am very sure it will not be so to your patient. Indeed, I am so narrow-minded myself, that if I had to choose between two physicians — one who did not know whether a whale is a fish or not, and could not tell gentian from ginger, but did understand the applications of the institutes of medicine to his art; while the other, like Talleyrand's doctor, "knew everything, even a little physic" — with all my love for breadth of culture, I should assuredly consult the former.

It is not pleasant to incur the suspicion of an inclination to injure or depreciate particular branches of knowledge, but the fact that one of those which I should have no hesitation in excluding from the medical curriculum, is that to which my own life has been specially devoted, should, at any rate, defend me from the suspicion of being urged to this course by any but the very gravest considerations of the public welfare.

And I should like, further, to call your attention to the important circumstance that, in thus proposing the exclusion of the study of such branches of knowledge as Zoology and Botany, from those compulsory upon the medical student, I am not, for a moment, suggesting their exclusion from the University. I think that sound and practical instruction in the elementary facts and broad principles of Biology should form part of the Arts Curriculum: and here, happily, my theory is in entire accordance with your practice. Moreover, as I have already said, I have no sort of doubt that, in view of the relation of Physical Science to the practical life of the present day, it has the same right as Theology, Law, and Medicine, to a Faculty of its own in which men shall be trained to be professional men of science. It may be doubted whether Universities are the places for technical schools of Engineering or applied Chemistry, or Agriculture. But there can surely be little question, that instruction in the branches of Science which lie at the foundation of these Arts, of a

far more advanced and special character than could, with any propriety, be included in the ordinary Arts Curriculum, ought to be obtainable by means of a duly organised Faculty of Science in every University.

The establishment of such a Faculty would have the additional advantage of providing, in some measure, for one of the greatest wants of our time and country. I mean the proper support and encouragement of original research.

The other day, an emphatic friend of mine committed himself to the opinion that, in England, it is better for a man's worldly prospects to be a drunkard, than to be smitten with the divine dipsomania of the original investigator. I am inclined to think he was not far wrong. And, be it observed, that the question is not, whether such a man shall be able to make as much out of his abilities as his brother, of like ability, who goes into Law, or Engineering, or Commerce; it is not a question of "maintaining a due number of saddle horses," as George Eliot somewhere puts it — it is a question of living or starving.

If a student of my own subject shows power and originality, I dare not advise him to adopt a scientific career; for, supposing he is able to maintain himself until he has attained distinction, I cannot give him the assurance that any amount of proficiency in the Biological Sciences will be convertible into, even the most modest, bread and cheese. And I believe that the case is as bad, or perhaps worse, with other branches of Science. In this respect Britain, whose immense wealth and prosperity hang upon the thread of Applied Science, is far behind France, and infinitely behind Germany.

And the worst of it is, that it is very difficult to see one's way to any immediate remedy for this state of affairs which shall be free from a tendency to become worse than the disease.

Great schemes for the Endowment of Research have been proposed. It has been suggested, that Laboratories for all branches of Physical Science, provided with every apparatus needed by the investigator, shall be established by the State: and shall be accessible, under due conditions and regulations, to all properly qualified persons. I see no objection to the principle of such a proposal. If it be legitimate to spend great sums of money on public Libraries and public collections of Painting and Sculpture, in aid of the Man of Letters, or the Artist, or for the mere sake of affording pleasure to the general public, I apprehend that it cannot be illegitimate to do as much for the promotion of scientific investigation. To take the lowest ground, as a mere investment of money, the latter is likely to be much more immediately profit-

able. To my mind, the difficulty in the way of such schemes is not theoretical, but practical. Given the laboratories, how are the investigators to be maintained? What career is open to those who have been thus encouraged to leave bread-winning pursuits? If they are to be provided for by endowment, we come back to the College Fellowship system, the results of which, for Literature, have not been so brilliant that one would wish to see it extended to Science; unless some much better securities than at present exist can be taken that it will foster real work. You know that among the Bees, it depends on the kind of cell in which the egg is deposited, and the quantity and quality of food which is supplied to the grub, whether it shall turn out a busy little worker or a big idle queen. And, in the human hive, the cells of the endowed larvæ are always tending to enlarge, and their food to improve, until we get queens, beautiful to behold, but which gather no honey and build no comb.

I do not say that these difficulties may not be overcome, but their gravity is not to be lightly estimated.

In the meanwhile, there is one step in the direction of the endowment of research which is free from such objections. It is possible to place the scientific enquirer in a position in which he shall have ample leisure and opportunity for original work, and yet shall give a fair and tangible equivalent for those privileges. The establishment of a Faculty of Science in every University, implies that of a corresponding number of Professorial chairs, the incumbents of which need not be so burdened with teaching as to deprive them of ample leisure for original work. I do not think that it is any impediment to an original investigator to have to devote a moderate portion of his time to lecturing, or superintending practical instruction. On the contrary, I think it may be, and often is, a benefit to be obliged to take a comprehensive survey of your subject; or to bring your results to a point, and give them, as it were, a tangible objective existence. The besetting sins of the investigator are two: the one is the desire to put aside a subject, the general bearings of which he has mastered himself, and pass on to something which has the attraction of novelty; and the other, the desire for too much perfection, which leads him to

> "Add and alter many times,
> Till all be ripe and rotten;"

to spend the energies which should be reserved for action in whitening the decks and polishing the guns.

The obligation to produce results for the instruction of others,

seems to me to be a more effectual check on these tendencies than even the love of usefulness or the ambition for fame.

But supposing the Professorial forces of our University to be duly organised, there remains an important question, relating to the teaching power, to be considered. Is the Professorial system — the system, I mean, of teaching in the lecture-room alone, and leaving the student to find his own way when he is outside the lecture-room — adequate to the wants of learners? In answering this question, I confine myself to my own province, and I venture to reply for Physical Science, assuredly and undoubtedly, No. As I have already intimated, practical work in the Laboratory is absolutely indispensable, and that practical work must be guided and superintended by a sufficient staff of Demonstrators, who are for Science what Tutors are for other branches of study. And there must be a good supply of such Demonstrators. I doubt if the practical work of more than twenty students can be properly superintended by one Demonstrator. If we take the working day at six hours, that is less than twenty minutes apiece — not a very large allowance of time for helping a dull man, for correcting an inaccurate one, or even for making an intelligent student clearly apprehend what he is about. And, no doubt, the supplying of a proper amount of this tutorial, practical teaching, is a difficulty in the way of giving proper instruction in Physical Science in such Universities as that of Aberdeen, which are devoid of endowments; and, unlike the English Universities, have no moral claim on the funds of richly endowed bodies to supply their wants.

Examination — thorough, searching examination — is an indispensable accompaniment of teaching; but I am almost inclined to commit myself to the very heterodox proposition that it is a necessary evil. I am a very old Examiner, having, for some twenty years past, been occupied with examinations on a considerable scale, of all sorts and conditions of men, and women too,— from the boys and girls of elementary schools to the candidates for Honours and Fellowships in the Universities. I will not say that, in this case as in so many others, the adage, that familiarity breeds contempt, holds good; but my admiration for the existing system of examination and its products, does not wax warmer as I see more of it. Examination, like fire, is a good servant, but a bad master; and there seems to me to be some danger of its becoming our master. I by no means stand alone in this opinion. Experienced friends of mine do not hesitate to say that students whose careers they watch, appear to them to become deteriorated by the constant effort to pass this or that examination,

just as we hear of men's brains becoming affected by the daily necessity of catching a train. They work to pass, not to know; and outraged Science takes her revenge. They do pass, and they don't know. I have passed sundry examinations in my time, not without credit, and I confess I am ashamed to think how very little real knowledge underlay the torrent of stuff which I was able to pour out on paper. In fact, that which examination, as ordinarily conducted, tests, is simply a man's power of work under stimulus, and his capacity for rapidly and clearly producing that which, for the time, he has got into his mind. Now, these faculties are by no means to be despised. They are of great value in practical life, and are the making of many an advocate, and of many a so-called statesman. But in the pursuit of truth, scientific or other, they count for very little, unless they are supplemented by that long-continued, patient "intending of the mind," as Newton phrased it, which makes very little show in Examinations. I imagine that an Examiner who knows his students personally, must not unfrequently have found himself in the position of finding A's paper better than B's, though his own judgment tells him, quite clearly, that B is the man who has the larger share of genuine capacity.

Again, there is a fallacy about Examiners. It is commonly supposed that any one who knows a subject is competent to teach it; and no one seems to doubt that any one who knows a subject is competent to examine in it. I believe both these opinions to be serious mistakes: the latter, perhaps, the more serious of the two. In the first place, I do not believe that any one who is not, or has not been, a teacher is really qualified to examine advanced students. And in the second place, Examination is an Art, and a difficult one, which has to be learned like all other arts.

Beginners always set too difficult questions — partly because they are afraid of being suspected of ignorance if they set easy ones, and partly from not understanding their business. Suppose that you want to test the relative physical strength of a score of young men. You do not put a hundredweight down before them, and tell each to swing it round. If you do, half of them won't be able to lift it at all, and only one or two will be able to perform the task. You must give them half a hundredweight, and see how they manœuvre that, if you want to form any estimate of the muscular strength of each. So, a practised Examiner will seek for information respecting the mental vigour and training of candidates from the way in which they deal with questions easy enough to let reason, memory, and method have free play.

No doubt, a great deal is to be done by the careful selection of Examiners, and by the copious introduction of practical work, to remove the evils inseparable from examination; but, under the best of circumstances, I believe that examination will remain but an imperfect test of knowledge, and a still more imperfect test of capacity, while it tells next to nothing about a man's power as an investigator.

There is much to be said in favour of restricting the highest degrees in each Faculty, to those who have shown evidence of such original power, by prosecuting a research under the eye of the Professor in whose province it lies; or, at any rate, under conditions which shall afford satisfactory proof that the work is theirs. The notion may sound revolutionary, but it is really very old; for, I take it, that it lies at the bottom of that presentation of a thesis by the candidate for a doctorate, which has now, too often, become little better than a matter of form.

Thus far, I have endeavoured to lay before you, in a too brief and imperfect manner, my views respecting the teaching half — the Magistri and Regentes — of the University of the Future. Now let me turn to the learning half — the Scholares.

If the Universities are to be sanctuaries of the highest culture of the country, those who would enter that sanctuary must not come with unwashed hands. If the good seed is to yield its hundredfold harvest, it must not be scattered amidst the stones of ignorance, or the tares of undisciplined indolence and wantonness. On the contrary, the soil must have been carefully prepared, and the Professor should find that the operations of clod-crushing, draining, and weeding, and even a good deal of planting, have been done by the Schoolmaster.

That is exactly what the Professor does not find in any University in the three Kingdoms that I can hear of — the reason of which state of things lies in the extremely faulty organisation of the majority of secondary schools. Students come to the Universities ill-prepared in classics and mathematics, not at all prepared in anything else; and half their time is spent in learning that which they ought to have known when they came.

I sometimes hear it said that the Scottish Universities differ from the English, in being to a much greater extent places of comparatively elementary education for a young class of students. But it would seem doubtful if any great difference of this kind really exists; for a high authority, himself Head of an English College, has solemnly affirmed that: "Elementary teaching of youths under twenty is now the only function performed by the

University;" and that Colleges are "boarding schools in which the elements of the learned languages are taught to youths." *

This is not the first time that I have quoted those remarkable assertions. I should like to engrave them in public view, for they have not been refuted; and I am convinced that if their import is once clearly apprehended, they will play no mean part when the question of University reorganisation, with a view to practical measures, comes on for discussion. You are not responsible for this anomalous state of affairs now; but, as you pass into active life and acquire the political influence to which your education and your position should entitle you, you will become responsible for it, unless each in his sphere does his best to alter it, by insisting on the improvement of secondary schools.

Your present responsibility is of another, though not less serious, kind. Institutions do not make men, any more than organisation makes life; and even the ideal University we have been dreaming about will be but a superior piece of mechanism, unless each student strive after the ideal of the Scholar. And that ideal, it seems to me, has never been better embodied than by the great Poet, who, though lapped in luxury, the favourite of a Court, and the idol of his countrymen, remained through all the length of his honoured years a Scholar in Art, in Science, and in Life.

"Wouldst shape a noble life? Then cast
No backward glances towards the past;
And though somewhat be lost and gone,
Yet do thou act as one new-born.
What each day needs, that shalt thou ask;
Each day will set its proper task.
Give others' work just share of praise;
Not of thine own the merits raise.
Beware no fellow man thou hate:
And so in God's hand leave thy fate." †

* *Suggestions for Academical Organisation, with Especial Reference to Oxford.* By the Rector of Lincoln.

† Goethe, *Zahme Xenien, Vierte Abtheilung.* I should be glad to take credit for the close and vigorous English version; but it is my wife's, and not mine.

IX.

ADDRESS ON UNIVERSITY EDUCATION.*

THE actual work of the University founded in this city by the well-considered munificence of Johns Hopkins commences to-morrow, and among the many marks of confidence and good-will which have been bestowed upon me in the United States, there is none which I value more highly than that conferred by the authorities of the University when they invited me to deliver an address on such an occasion.

For the event which has brought us together is, in many respects, unique. A vast property is handed over to an administrative body, hampered by no conditions save these: — That the principal shall not be employed in building: that the funds shall be appropriated, in equal proportions, to the promotion of natural knowledge and to the alleviation of the bodily sufferings of mankind; and, finally, that neither political nor ecclesiastical sectarianism shall be permitted to disturb the impartial distribution of the testator's benefactions.

In my experience of life a truth which sounds very much like a paradox has often asserted itself: namely, that a man's worst difficulties begin when he is able to do as he likes. So long as a man is struggling with obstacles he has an excuse for failure or shortcoming; but when fortune removes them all and gives him the power of doing as he thinks best, then comes the time of trial. There is but one right, and the possibilities of wrong are infinite. I doubt not that the trustees of the Johns Hopkins University felt the full force of this truth when they entered on the administration of their trust a year and a half ago; and I can but admire the activity and resolution which have enabled them, aided by the able president whom they have selected, to lay down the great outlines of their plan, and carry it thus far into execution. It is

* Delivered at the formal opening of the Johns Hopkins University at Baltimore, U. S. The total amount bequeathed by Johns Hopkins is more than 7,000,000 dollars. The sum of 3,500,000 dollars is appropriated to a university, a like sum to a hospital, and the rest to local institutions of education and charity.

impossible to study that plan without perceiving that great care, forethought, and sagacity, have been bestowed upon it, and that it demands the most respectful consideration. I have been endeavouring to ascertain how far the principles which underlie it are in accordance with those which have been established in my own mind by much and long-continued thought upon educational questions. Permit me to place before you the result of my reflections.

Under one aspect a university is a particular kind of educational institution, and the views which we may take of the proper nature of a university are corollaries from those which we hold respecting education in general. I think it must be admitted that the school should prepare for the university, and that the university should crown the edifice, the foundations of which are laid in the school. University education should not be something distinct from elementary education, but should be the natural outgrowth and development of the latter. Now I have a very clear conviction as to what elementary education ought to be; what it really may be, when properly organised; and what I think it will be, before many years have passed over our heads, in England and in America. Such education should enable an average boy of fifteen or sixteen to read and write his own language with ease and accuracy, and with a sense of literary excellence derived from the study of our classic writers: to have a general acquaintance with the history of his own country and with the great laws of social existence; to have acquired the rudiments of the physical and psychological sciences, and a fair knowledge of elementary arithmetic and geometry. He should have obtained an acquaintance with logic rather by example than by precept; while the acquirement of the elements of music and drawing should have been pleasure rather than work.

It may sound strange to many ears if I venture to maintain the proposition that a young person, educated thus far, has had a liberal, though perhaps not a full education. But it seems to me that such training as that to which I have referred may be termed liberal, in both the senses in which that word is employed, with perfect accuracy. In the first place, it is liberal in breadth. It extends over the whole ground of things to be known and of faculties to be trained, and it gives equal importance to the two great sides of human activity — art and science. In the second place, it is liberal in the sense of being an education fitted for free men; for men to whom every career is open, and from whom their country may demand that they should be fitted to perform the duties of any career. I cannot too strongly impress upon you the

fact that, with such a primary education as this, and with no more than is to be obtained by building strictly upon its lines, a man of ability may become a great writer or speaker, a statesman, a lawyer, a man of science, painter, sculptor, architect, or musician. That even development of all a man's faculties, which is what properly constitutes culture, may be effected by such an education, while it opens the way for the indefinite strengthening of any special capabilities with which he may be gifted.

In a country like this, where most men have to carve out their own fortunes and devote themselves early to the practical affairs of life, comparatively few can hope to pursue their studies up to, still less beyond, the age of manhood. But it is of vital importance to the welfare of the community that those who are relieved from the need of making a livelihood, and still more, those who are stirred by the divine impulses of intellectual thirst or artistic genius, should be enabled to devote themselves to the higher service of their kind, as centres of intelligence, interpreters of Nature, or creators of new forms of beauty. And it is the function of a university to furnish such men with the means of becoming that which it is their privilege and duty to be. To this end the university need cover no ground foreign to that occupied by the elementary school. Indeed it cannot; for the elementary instruction which I have referred to embraces all the kinds of real knowledge and mental activity possible to man. The university can add no new departments of knowledge, can offer no new fields of mental activity; but what it can do is to intensify and specialise the instruction in each department. Thus literature and philology, represented in the elementary school by English alone, in the University will extend over the ancient and modern languages. History, which, like charity, best begins at home, but, like charity, should not end there, will ramify into anthropology, archæology, political history, and geography, with the history of the growth of the human mind and of its products in the shape of philosophy, science, and art. And the university will present to the student libraries, museums of antiquities, collections of coins, and the like, which will efficiently subserve these studies. Instruction in the elements of social economy, a most essential, but hitherto sadly-neglected part of elementary education, will develop in the university into political economy, sociology, and law. Physical science will have its great divisions of physical geography, with geology and astronomy; physics; chemistry and biology; represented not merely by professors and their lectures, but by laboratories, in which the students, under guidance of demonstrators, will work out facts for themselves and come into

that direct contact with reality which constitutes the fundamental distinction of scientific education. Mathematics will soar into its highest regions; while the high peaks of philosophy may be scaled by those whose aptitude for abstract thought has been awakened by elementary logic. Finally, schools of pictorial and plastic art, of architecture, and of music, will offer a thorough discipline in the principles and practice of art to those in whom lies nascent the rare faculty of æsthetic representation, or the still rarer powers of creative genius.

The primary school and the university are the alpha and omega of education. Whether institutions intermediate between these (so-called secondary schools) should exist, appears to me to be a question of practical convenience. If such schools are established, the important thing is that they should be true intermediaries between the primary school and the university, keeping on the wide track of general culture, and not sacrificing one branch of knowledge for another.

Such appear to me to be the broad outlines of the relations which the university, regarded as a place of education, ought to bear to the school, but a number of points of detail require some consideration, however briefly and imperfectly I can deal with them. In the first place, there is the important question of the limitations which should be fixed to the entrance into the university; or, what qualifications should be required of those who propose to take advantage of the higher training offered by the university. On the one hand, it is obviously desirable that the time and opportunities of the university should not be wasted in conferring such elementary instruction as can be obtained elsewhere; while, on the other hand, it is no less desirable that the higher instruction of the university should be made accessible to every one who can take advantage of it, although he may not have been able to go through any very extended course of education. My own feeling is distinctly against any absolute and defined preliminary examination, the passing of which shall be an essential condition of admission to the university. I would admit to the university any one who could be reasonably expected to profit by the instruction offered to him; and I should be inclined, on the whole, to test the fitness of the student, not by examination before he enters the university, but at the end of his first term of study. If, on examination in the branches of knowledge to which he has devoted himself, he show himself deficient in industry or in capacity, it will be best for the university and best for himself, to prevent him from pursuing a vocation for which he is obviously unfit. And I hardly know of any other method than this by which his fitness

or unfitness can be safely ascertained, though no doubt a good deal may be done, not by formal cut and dried examination, but by judicious questioning, at the outset of his career.

Another very important and difficult practical question is, whether a definite course of study shall be laid down for those who enter the university; whether a curriculum shall be prescribed; or whether the student shall be allowed to range at will among the subjects which are open to him. And this question is inseparably connected with another, namely, the conferring of degrees. It is obviously impossible that any student should pass through the whole of the series of courses of instruction offered by a university. If a degree is to be conferred as a mark of proficiency in knowledge, it must be given on the ground that the candidate is proficient in a certain fraction of those studies; and then will arise the necessity of insuring an equivalency of degrees, so that the course by which a degree is obtained shall mark approximately an equal amount of labour and of acquirements, in all cases. But this equivalency can hardly be secured in any other way than by prescribing a series of definite lines of study. This is a matter which will require grave consideration. The important points to bear in mind, I think, are that there should not be too many subjects in the curriculum, and that the aim should be the attainment of thorough and sound knowledge of each.

One half of the Johns Hopkins bequest is devoted to the establishment of a hospital, and it was the desire of the testator that the university and the hospital should co-operate in the promotion of medical education. The trustees will unquestionably take the best advice that is to be had as to the construction and administration of the hospital. In respect to the former point, they will doubtless remember that a hospital may be so arranged as to kill more than it cures; and, in regard to the latter, that a hospital may spread the spirit of pauperism among the well-to-do, as well as relieve the sufferings of the destitute. It is not for me to speak on these topics — rather let me confine myself to the one matter on which my experience as a student of medicine, and an examiner of long standing, who has taken a great interest in the subject of medical education, may entitle me to a hearing. I mean the nature of medical education itself, and the co-operation of the university in its promotion.

What is the object of medical education? It is to enable the practitioner, on the one hand, to prevent disease by his knowledge of hygiene; on the other hand, to divine its nature, and to alleviate or cure it, by his knowledge of pathology, therapeutics, and

practical medicine. That is his business in life, and if he has not a thorough and practical knowledge of the conditions of health, of the causes which tend to the establishment of disease, of the meaning of symptoms, and of the uses of medicines and operative appliances, he is incompetent, even if he were the best anatomist, or physiologist, or chemist, that ever took a gold medal or won a prize certificate. This is one great truth respecting medical education. Another is, that all practice in medicine is based upon theory of some sort or other; and therefore, that it is desirable to have such theory in the closest possible accordance with fact. The veriest empiric who gives a drug in one case because he has seen it do good in another of apparently the same sort, acts upon the theory that similarity of superficial symptoms means similarity of lesions; which, by the way, is perhaps as wild an hypothesis as could be invented. To understand the nature of disease we must understand health, and the understanding of the healthy body means the having a knowledge of its structure and of the way in which its manifold actions are performed, which is what is technically termed human anatomy and human physiology. The physiologist again must needs possess an acquaintance with physics and chemistry, inasmuch as physiology is, to a great extent, applied physics and chemistry. For ordinary purposes a limited amount of such knowledge is all that is needful; but for the pursuit of the higher branches of physiology no knowledge of these branches of science can be too extensive, or too profound. Again, what we call therapeutics, which has to do with the action of drugs and medicines on the living organism, is, strictly speaking, a branch of experimental physiology, and is daily receiving a greater and greater experimental development.

The third great fact which is to be taken into consideration in dealing with medical education, is that the practical necessities of life do not, as a rule, allow aspirants to medical practice to give more than three, or it may be four years to their studies. Let us put it at four years, and then reflect that, in the course of this time, a young man fresh from school has to acquaint himself with medicine, surgery, obstetrics, therapeutics, pathology, hygiene, as well as with the anatomy and the physiology of the human body; and that his knowledge should be of such a character that it can be relied upon in any emergency, and always ready for practical application. Consider, in addition, that the medical practitioner may be called upon, at any moment, to give evidence in a court of justice in a criminal case; and that it is therefore well that he should know something of the laws of evidence, and of what we call medical jurisprudence. On a medical certificate,

a man may be taken from his home and from his business and confined in a lunatic asylum; surely, therefore, it is desirable that the medical practitioner should have some rational and clear conceptions as to the nature and symptoms of mental disease. Bearing in mind all these requirements of medical education, you will admit that the burden on the young aspirant for the medical profession is somewhat of the heaviest, and that it needs some care to prevent his intellectual back from being broken.

Those who are acquainted with the existing systems of medical education will observe that, long as is the catalogue of studies which I have enumerated, I have omitted to mention several that enter into the usual medical curriculum of the present day. I have said not a word about zoology, comparative anatomy, botany, or materia medica. Assuredly this is from no light estimate of the value or importance of such studies in themselves. It may be taken for granted that I should be the last person in the world to object to the teaching of zoology, or comparative anatomy, in themselves; but I have the strongest feeling that, considering the number and the gravity of those studies through which a medical man must pass, if he is to be competent to discharge the serious duties which devolve upon him, subjects which lie so remote as these do from his practical pursuits should be rigorously excluded. The young man, who has enough to do in order to acquire such familiarity with the structure of the human body as will enable him to perform the operations of surgery, ought not, in my judgment, to be occupied with investigations into the anatomy of crabs and starfishes. Undoubtedly the doctor should know the common poisonous plants of his own country when he sees them; but that knowledge may be obtained by a few hours devoted to the examination of specimens of such plants, and the desirableness of such knowledge is no justification, to my mind, for spending three months over the study of systematic botany. Again, materia medica, so far as it is a knowledge of drugs, is the business of the druggist. In all other callings the necessity of the division of labour is fully recognised, and it is absurd to require of the medical man that he should not avail himself of the special knowledge of those whose business it is to deal in the drugs which he uses. It is all very well that the physician should know that castor oil comes from a plant, and castoreum from an animal, and how they are to be prepared; but for all the practical purposes of his profession that knowledge is not of one whit more value, has no more relevancy, than the knowledge of how the steel of his scalpel is made.

All knowledge is good. It is impossible to say that any frag-

ment of knowledge, however insignificant or remote from one's ordinary pursuits, may not some day be turned to account. But in medical education, above all things, it is to be recollected that, in order to know a little well, one must be content to be ignorant of a great deal.

Let it not be supposed that I am proposing to narrow medical education, or, as the cry is, to lower the standard of the profession. Depend upon it there is only one way of really ennobling any calling, and that is to make those who pursue it real masters of their craft, men who can truly do that which they profess to be able to do, and which they are credited with being able to do by the public. And there is no position so ignoble as that of the so-called "liberally-educated practitioner," who may be able to read Galen in the original; who knows all the plants, from the cedar of Lebanon to the hyssop upon the wall; but who finds himself, with the issues of life and death in his hands, ignorant, blundering, and bewildered, because of his ignorance of the essential and fundamental truths upon which practice must be based. Moreover, I venture to say, that any man who has seriously studied all the essential branches of medical knowledge; who has the needful acquaintance with the elements of physical science; who has been brought by medical jurisprudence into contact with law; whose study of insanity has taken him into the fields of psychology; has *ipso facto* received a liberal education.

Having lightened the medical curriculum by culling out of it everything which is unessential, we may next consider whether something may not be done to aid the medical student toward the acquirement of real knowledge by modifying the system of examination. In England, within my recollection, it was the practice to require of the medical student attendance on lectures upon the most diverse topics during three years; so that it often happened that he would have to listen, in the course of a day, to four or five lectures upon totally different subjects, in addition to the hours given to dissection and to hospital practice: and he was required to keep all the knowledge he could pick up, in this distracting fashion, at examination point, until, at the end of three years, he was set down to a table and questioned pell-mell upon all the different matters with which he had been striving to make acquaintance. A worse system and one more calculated to obstruct the acquisition of sound knowledge and to give full play to the "crammer" and the "grinder" could hardly have been devised by human ingenuity. Of late years great reforms have taken place. Examinations have been divided so as to diminish the number of subjects among which the attention has to be dis-

tributed. Practical examination has been largely introduced; but there still remains, even under the present system, too much of the old evil inseparable from the contemporaneous pursuit of a multiplicity of diverse studies.

Proposals have recently been made to get rid of general examinations altogether, to permit the student to be examined in each subject at the end of his attendance on the class; and then, in case of the result being satisfactory, to allow him to have done with it; and I may say that this method has been pursued for many years in the Royal School of Mines in London, and has been found to work very well. It allows the student to concentrate his mind upon what he is about for the time being, and then to dismiss it. Those who are occupied in intellectual work, will, I think, agree with me that it is important, not so much to know a thing, as to have known it, and known it thoroughly. If you have once known a thing in this way it is easy to renew your knowledge when you have forgotten it; and when you begin to take the subject up again, it slides back upon the familiar grooves with great facility.

Lastly comes the question as to how the university may co-operate in advancing medical education. A medical school is strictly a technical school — a school in which a practical profession is taught — while a university ought to be a place in which knowledge is obtained without direct reference to professional purposes. It is clear, therefore, that a university and its antecedent, the school, may best co-operate with the medical school by making due provision for the study of those branches of knowledge which lie at the foundation of medicine.

At present, young men come to the medical schools without a conception of even the elements of physical science; they learn, for the first time, that there are such sciences as physics, chemistry, and physiology, and are introduced to anatomy as a new thing. It may be safely said that, with a large proportion of medical students, much of the first session is wasted in learning how to learn — in familiarising themselves with utterly strange conceptions, and in awakening their dormant and wholly untrained powers of observation and of manipulation. It is difficult to over-estimate the magnitude of the obstacles which are thrown in the way of scientific training by the existing system of school education. Not only are men trained in mere book-work, ignorant of what observation means, but the habit of learning from books alone begets a disgust of observation. The book-learned student will rather trust to what he sees in a book than to witness of his own eyes.

There is not the least reason why this should be so, and, in fact, when elementary education becomes that which I have assumed it ought to be, this state of things will no longer exist. There is not the slightest difficulty in giving sound elementary instruction in physics, in chemistry, and in the elements of human physiology, in ordinary schools. In other words, there is no reason why the student should not come to the medical school, provided with as much knowledge of these several sciences as he ordinarily picks up in the course of his first year of attendance at the medical school.

I am not saying this without full practical justification for the statement. For the last eighteen years we have had in England a system of elementary science teaching carried out under the auspices of the Science and Art Department, by which elementary scientific instruction is made readily accessible to the scholars of all the elementary schools in the country. Commencing with small beginnings, carefully developed and improved, that system now brings up for examination as many as seven thousand scholars in the subject of human physiology alone. I can say that, out of that number, a large proportion have acquired a fair amount of substantial knowledge; and that no inconsiderable percentage show as good an acquaintance with human physiology as used to be exhibited by the average candidates for medical degrees in the University of London, when I was first an examiner there twenty years ago; and quite as much knowledge as is possessed by the ordinary student of medicine at the present day. I am justified, therefore, in looking forward to the time when the student who proposes to devote himself to medicine will come, not absolutely raw and inexperienced as he is at present, but in a certain state of preparation for further study; and I look to the university to help him still further forward in that stage of preparation, through the organisation of its biological department. Here the student will find means of acquainting himself with the phenomena of life in their broadest acceptation. He will study not botany and zoology, which, as I have said, would take him too far away from his ultimate goal; but, by duly arranged instruction, combined with work in the laboratory upon the leading types of animal and vegetable life, he will lay a broad, and at the same time solid, foundation of biological knowledge; he will come to his medical studies with a comprehension of the great truths of morphology and of physiology, with his hands trained to dissect and his eyes taught to see. I have no hesitation in saying that such preparation is worth a full year added on to the medical curriculum. In other words, it will set free that

much time for attention to those studies which bear directly upon the student's most grave and serious duties as a medical practitioner.

Up to this point I have considered only the teaching aspect of your great foundation, that function of the university in virtue of which it plays the part of a reservoir of ascertained truth, so far as our symbols can ever interpret nature. All can learn; all can drink of this lake. It is given to few to add to the store of knowledge, to strike new springs of thought, or to shape new forms of beauty. But so sure as it is that men live not by bread, but by ideas, so sure is it that the future of the world lies in the hands of those who are able to carry the interpretation of nature a step further than their predecessors; so certain is it that the highest function of a university is to seek out those men, cherish them, and give their ability to serve their kind full play.

I rejoice to observe that the encouragement of research occupies so prominent a place in your official documents, and in the wise and liberal inaugural address of your president. This subject of the encouragement, or, as it is sometimes called, the endowment of research, has of late years greatly exercised the minds of men in England. It was one of the main topics of discussion by the members of the Royal Commission of whom I was one, and who not long since issued their report, after five years' labour. Many seem to think that this question is mainly one of money; that you can go into the market and buy research, and that supply will follow demand, as in the ordinary course of commerce. This view does not commend itself to my mind. I know of no more difficult practical problem than the discovery of a method of encouraging and supporting the original investigator without opening the door to nepotism and jobbery. My own conviction is admirably summed up in the passage of your president's address, "that the best investigators are usually those who have also the responsibilities of instruction, gaining thus the incitement of colleagues, the encouragement of pupils, and the observation of the public."

At the commencement of this address I ventured to assume that I might, if I thought fit, criticise the arrangements which have been made by the board of trustees, but I confess that I have little to do but to applaud them. Most wise and sagacious seems to me the determination not to build for the present. It has been my fate to see great educational funds fossilise into mere bricks and mortar, in the petrifying springs of architecture, with nothing left to work the institution they were intended to support. A great warrior is said to have made a desert and called it peace.

Administrators of educational funds have sometimes made a palace and called it a university. If I may venture to give advice in a matter which lies out of my proper competency, I would say that whenever you do build, get an honest bricklayer, and make him build you just such rooms as you really want, leaving ample space for expansion. And a century hence, when the Baltimore and Ohio shares are at one thousand premium, and you have endowed all the professors you need and built all the laboratories that are wanted, and have the best museum and the finest library that can be imagined; then, if you have a few hundred thousand dollars you don't know what to do with, send for an architect and tell him to put up a façade. If American is similar to English experience, any other course will probably lead you into having some stately structure, good for your architect's fame, but not in the least what you want.

It appears to me that what I have ventured to lay down as the principles which should govern the relations of a university to education in general, are entirely in accordance with the measures you have adopted. You have set no restrictions upon access to the instruction you propose to give; you have provided that such instruction, either as given by the university or by associated institutions, should cover the field of human intellectual activity. You have recognised the importance of encouraging research. You propose to provide means by which young men, who may be full of zeal for a literary or for a scientific career, but who also may have mistaken aspiration for inspiration, may bring their capacities to a test, and give their powers a fair trial. If such a one fail, his endowment terminates, and there is no harm done. If he succeed, you may give power of flight to the genius of a Davy or a Faraday, a Carlyle or a Locke, whose influence on the future of his fellow-men shall be absolutely incalculable.

You have enunciated the principle that "the glory of the university should rest upon the character of the teachers and scholars, and not upon the number of buildings constructed for their use." And I look upon it as an essential and most important feature of your plan that the income of the professors and teachers shall be independent of the number of students whom they can attract. In this way you provide against the danger, patent elsewhere, of finding attempts at improvement obstructed by vested interests; and, in the department of medical education especially, you are free of the temptation to set loose upon the world men utterly incompetent to perform the serious and responsible duties of their profession.

It is a delicate matter for a stranger to the practical working of your institutions, like myself, to pretend to give an opinion as to the organisation of your governing power. I can conceive nothing better than that it should remain as it is, if you can secure a succession of wise, liberal, honest, and conscientious men to fill the vacancies that occur among you. I do not greatly believe in the efficacy of any kind of machinery for securing such a result; but I would venture to suggest that the exclusive adoption of the method of co-optation for filling the vacancies which must occur in your body, appears to me to be somewhat like a tempting of Providence. Doubtless there are grave practical objections to the appointment of persons outside of your body and not directly interested in the welfare of the university; but might it not be well if there were an understanding that your academic staff should be officially represented on the board, perhaps even the heads of one or two independent learned bodies, so that academic opinion and the views of the outside world might have a certain influence in that most important matter, the appointment of your professors? I throw out these suggestions, as I have said, in ignorance of the practical difficulties that may lie in the way of carrying them into effect, on the general ground that personal and local influences are very subtle, and often unconscious, while the future greatness and efficiency of the noble institution which now commences its work must largely depend upon its freedom from them.

I constantly hear Americans speak of the charm which our old mother country has for them, of the delight with which they wander through the streets of ancient towns, or climb the battlements of mediæval strongholds, the names of which are indissolubly associated with the great epochs of that noble literature which is our common inheritance; or with the blood-stained steps of that secular progress, by which the descendants of the savage Britons and of the wild pirates of the North Sea have become converted into warriors of order and champions of peaceful freedom, exhausting what still remains of the old Berserk spirit in subduing nature, and turning the wilderness into a garden. But anticipation has no less charm than retrospect, and to an Englishman landing upon your shores for the first time, travelling for hundreds of miles through strings of great and well-ordered cities, seeing your enormous actual, and almost infinite potential wealth, in all commodities, and in the energy and ability which turn wealth to account, there is something sublime in the vista of the future. Do not suppose that I am pandering to what

is commonly understood by national pride. I cannot say that I am in the slightest degree impressed by your bigness, or your material resources, as such. Size is not grandeur, and territory does not make a nation. The great issue, about which hangs a true sublimity, and the terror of overhanging fate, is what are you going to do with all these things? What is to be the end to which these are to be the means? You are making a novel experiment in politics on the greatest scale which the world has yet seen. Forty millions at your first centenary, it is reasonably to be expected that, at the second, these states will be occupied by two hundred millions of English-speaking people, spread over an area as large as that of Europe, and with climates and interests as diverse as those of Spain and Scandinavia, England and Russia. You and your descendants have to ascertain whether this great mass will hold together under the forms of a republic, and the despotic reality of universal suffrage; whether state rights will hold out against centralisation, without separation, whether centralisation will get the better, without actual or disguised monarchy; whether shifting corruption is better than a permanent bureaucracy; and as population thickens in your great cities, and the pressure of want is felt, the gaunt spectre of pauperism will stalk among you, and communism and socialism will claim to be heard. Truly America has a great future before her; great in toil, in care, and in responsibility; great in true glory if she be guided in wisdom and righteousness; great in shame if she fail. I cannot understand why other nations should envy you, or be blind to the fact that it is for the highest interest of mankind that you should succeed; but the one condition of success, your sole safeguard, is the moral worth and intellectual clearness of the individual citizen. Education cannot give these, but it may cherish them and bring them to the front in whatever station of society they are to be found; and the universities ought to be, and may be, the fortresses of the higher life of the nation.

May the university which commences its practical activity to-morrow abundantly fulfil its high purpose; may its renown as a seat of true learning, a centre of free inquiry, a focus of intellectual light, increase year by year, until men wander hither from all parts of the earth, as of old they sought Bologna, or Paris, or Oxford.

And it is pleasant to me to fancy that, among the English students who are drawn to you at that time, there may linger a dim tradition that a countryman of theirs was permitted to address you as he has done to-day, and to feel as if your hopes were his hopes and your success his joy.

X.

ON THE STUDY OF BIOLOGY.

IT is my duty to-night to speak about the study of Biology, and while it may be that there are many of my audience who are quite familiar with that study, yet as a lecturer of some standing, it would, I know by experience, be very bad policy on my part to suppose such to be extensively the case. On the contrary, I must imagine that there are many of you who would like to know what Biology is; that there are others who have that amount of information, but would nevertheless gladly hear why it should be worth their while to study Biology; and yet others, again, to whom these two points are clear, but who desire to learn how they had best study it, and, finally, when they had best study it.

I shall, therefore, address myself to the endeavour to give you some answer to these four questions — what Biology is; why it should be studied; how it should be studied; and when it should be studied.

In the first place, in respect to what Biology is, there are, I believe, some persons who imagine that the term "Biology" is simply a new-fangled denomination, a neologism in short, for what used to be known under the title of "Natural History"; but I shall try to show you, on the contrary, that the word is the expression of the growth of science during the last 200 years, and came into existence half a century ago.

At the revival of learning, knowledge was divided into two kinds — the knowledge of nature and the knowledge of man; for it was the current idea then (and a great deal of that ancient conception still remains) that there was a sort of essential antithesis, not to say antagonism, between nature and man; and that the two had not very much to do with one another, except that the one was oftentimes exceedingly troublesome to the other. Though it is one of the salient merits of our great philosophers of the seventeenth century, that they recognised but one scientific method, applicable alike to man and to nature, we find this notion of the existence of a broad distinction between nature and man

in the writings both of Bacon and of Hobbes of Malmesbury; and I have brought with me that famous work which is now so little known, greatly as it deserves to be studied, "The Leviathan," in order that I may put to you in the wonderfully terse and clear language of Thomas Hobbes, what was his view of the matter. He says:—

"The register of knowledge of fact is called history. Whereof there be two sorts, one called natural history; which is the history of such facts or effects of nature as have no dependence on man's will; such as are the histories of metals, plants, animals, regions, and the like. The other is civil history; which is the history of the voluntary actions of men in commonwealths."

So that all history of fact was divided into these two great groups of natural and of civil history. The Royal Society was in course of foundation about the time that Hobbes was writing this book, which was published in 1651; and that Society was termed a "Society for the Improvement of Natural Knowledge," which was then nearly the same thing as a "Society for the Improvement of Natural History." As time went on, and the various branches of human knowledge became more distinctly developed and separated from one another, it was found that some were much more susceptible of precise mathematical treatment than others. The publication of the "Principia" of Newton, which probably gave a greater stimulus to physical science than any work ever published before, or which is likely to be published hereafter, showed that precise mathematical methods were applicable to those branches of science such as astronomy, and what we now call physics, which occupy a very large portion of the domain of what the older writers understood by natural history. And inasmuch as the partly deductive and partly experimental methods of treatment to which Newton and others subjected these branches of human knowledge, showed that the phenomena of nature which belonged to them were susceptible of explanation, and thereby came within the reach of what was called "philosophy," in those days; so much of this kind of knowledge as was not included under astronomy came to be spoken of as "natural philosophy"—a term which Bacon had employed in a much wider sense. Time went on, and yet other branches of science developed themselves. Chemistry took a definite shape; and since all these sciences, such as astronomy, natural philosophy, and chemistry, were susceptible either of mathematical treatment or of experimental treatment, or of both, a broad distinction was drawn between the experimental branches of what had previously been called natural history and the observational branches—those in which experiment was (or appeared

to be) of doubtful use, and where, at that time, mathematical methods were inapplicable. Under these circumstances the old name of "Natural History" stuck by the residuum of those phenomena which were not, at that time, susceptible of mathematical or experimental treatment; that is to say, those phenomena of nature which come now under the general heads of physical geography, geology, mineralogy, the history of plants, and the history of animals. It was in this sense that the term was understood by the great writers of the middle of the last century — Buffon and Linnæus — by Buffon in his great work, the "Histoire Naturelle Générale," and by Linnæus in his splendid achievement, the "Systema Naturæ." The subjects they deal with are spoken of as "Natural History," and they called themselves and were called "Naturalists." But you will observe that this was not the original meaning of these terms; but that they had, by this time, acquired a signification widely different from that which they possessed primitively.

The sense in which "Natural History" was used at the time I am now speaking of has, to a certain extent, endured to the present day. There are now in existence in some of our northern universities, chairs of "Civil and Natural History" in which "Natural History" is used to indicate exactly what Hobbes and Bacon meant by that term. The unhappy incumbent of the chair of Natural History is, or was, supposed to cover the whole ground of geology, mineralogy, and zoology, perhaps even botany, in his lectures.

But as science made the marvellous progress which it did make at the latter end of the last and the beginning of the present century, thinking men began to discern that under this title of "Natural History" there were included very heterogeneous constituents — that, for example, geology and mineralogy were, in many respects, widely different from botany and zoology; that a man might obtain an extensive knowledge of the structure and functions of plants and animals without having need to enter upon the study of geology or mineralogy, and *vice versâ;* and, further as knowledge advanced, it became clearer that there was a great analogy, a very close alliance, between those two sciences, of botany and zoology, which deal with living beings, while they are much more widely separated from all other studies. It is due to Buffon to remark that he clearly recognised this great fact. He says: "Ces deux genres d'êtres organisés [les animaux et les végétaux] ont beaucoup plus de propriétés communes que de différénces réelles." Therefore, it is not wonderful that, at the beginning of the present century, in two different countries, and

so far as I know, without any intercommunication, two famous men clearly conceived the notion of uniting the sciences which deal with living matter into one whole, and of dealing with them as one discipline. In fact, I may say there were three men to whom this idea occurred contemporaneously, although there were but two who carried it into effect, and only one who worked it out completely. The persons to whom I refer were the eminent physiologist Bichat, and the great naturalist Lamarck, in France; and a distinguished German, Treviranus. Bichat assumed the existence of a special group of "physiological" sciences. Lamarck, in a work published in 1801, for the first time made use of the name "Biologie," from the two Greek words which signify a discourse upon life and living things. About the same time it occurred to Treviranus, that all those sciences which deal with living matter are essentially and fundamentally one, and ought to be treated as a whole; and, in the year 1802, he published the first volume of what he also called "Biologie." Treviranus's great merit lies in this, that he worked out his idea, and wrote the very remarkable book to which I refer. It consists of six volumes, and occupied its author for twenty years — from 1802 to 1822.

That is the origin of the term "Biology"; and that is how it has come about that all clear thinkers and lovers of consistent nomenclature have substituted for the old confusing name of "Natural History," which has conveyed so many meanings, the term "Biology" which denotes the whole of the sciences which deal with living things, whether they be animals or whether they be plants. Some little time ago — in the course of this year, I think — I was favoured by a learned classic, Dr. Field of Norwich, with a disquisition, in which he endeavoured to prove that, from a philological point of view, neither Treviranus nor Lamarck had any right to coin this new word "Biology" for their purpose; that, in fact, the Greek word "Bios" had relation only to human life and human affairs, and that a different word was employed by the Greeks when they wished to speak of the life of animals and plants. So Dr. Field tells us we are all wrong in using the term biology, and that we ought to employ another; only he is not sure about the propriety of that which he proposes as a substitute. It is a somewhat hard one — "zootocology." I am sorry we are wrong, because we are likely to continue so. In these matters we must have some sort of "Statute of Limitations." When a name has been employed for half a

has become well understood, I am afraid people will go on using it, whatever the weight of philological objection.

Now that we have arrived at the origin of this word "Biology," the next point to consider is: What ground does it cover? I have said that in its strict technical sense, it denotes all the phenomena which are exhibited by living things, as distinguished from those which are not living; but while that is all very well, so long as we confine ourselves to the lower animals and to plants, it lands us in considerable difficulties when we reach the higher forms of living things. For whatever view we may entertain about the nature of man, one thing is perfectly certain, that he is a living creature. Hence, if our definition is to be interpreted strictly, we must include man and all his ways and works under the head of Biology; in which case, we should find that psychology, politics, and political economy would be absorbed into the province of Biology. In fact, civil history would be merged in natural history. In strict logic it may be hard to object to this course, because no one can doubt that the rudiments and outlines of our own mental phenomena are traceable among the lower animals. They have their economy and their polity, and if, as is always admitted, the polity of bees and the commonwealth of wolves fall within the purview of the biologist proper, it becomes hard to say why we should not include therein human affairs, which, in so many cases, resemble those of the bees in zealous getting, and are not without a certain parity in the proceedings of the wolves. The real fact is that we biologists are a self-sacrificing people; and inasmuch as, on a moderate estimate, there are about a quarter of a million different species of animals and plants to know about already, we feel that we have more than sufficient territory. There has been a sort of practical convention by which we give up to a different branch of science what Bacon and Hobbes would have called "Civil History." That branch of science has constituted itself under the head of Sociology. I may use phraseology which, at present, will be well understood and say that we have allowed that province of Biology to become autonomous; but I should like you to recollect that that is a sacrifice, and that you should not be surprised if it occasionally happens that you see a biologist apparently trespassing in the region of philosophy or politics; or meddling with human education; because, after all, that is a part of his kingdom which he has only voluntarily forsaken.

Having now defined the meaning of the word Biology, and having indicated the general scope of Biological Science, I turn to my second question, which is — Why should we study Biology.

Possibly the time may come when that will seem a very odd question. That we, living creatures, should not feel a certain amount of interest in what it is that constitutes our life will eventually, under altered ideas of the fittest objects of human inquiry, appear to be a singular phenomenon; but at present, judging by the practice of teachers and educators, Biology would seem to be a topic that does not concern us at all. I propose to put before you a few considerations with which I dare say many will be familiar already, but which will suffice to show — not fully, because to demonstrate this point fully would take a great many lectures — that there are some very good and substantial reasons why it may be advisable that we should know something about this branch of human learning.

I myself entirely agree with another sentiment of the philosopher of Malmesbury, "that the scope of all speculation is the performance of some action or thing to be done," and I have not any very great respect for, or interest in, mere knowing as such. I judge of the value of human pursuits by their bearing upon human interests; in other words, by their utility; but I should like that we should quite clearly understand what it is that we mean by this word "utility." In an Englishman's mouth it generally means that by which we get pudding or praise, or both. I have no doubt that is one meaning of the word utility, but it by no means includes all I mean by utility. I think that knowledge of every kind is useful in proportion as it tends to give people right ideas, which are essential to the foundation of right practice, and to remove wrong ideas, which are the no less essential foundations and fertile mothers of every description of error in practice. And inasmuch as, whatever practical people may say; this world is, after all, absolutely governed by ideas, and very often by the wildest and most hypothetical ideas, it is a matter of the very greatest importance that our theories of things, and even of things that seem a long way apart from our daily lives, should be as far as possible true, and as far as possible removed from error. It is not only in the coarser, practical sense of the word "utility," but in this higher and broader sense, that I measure the value of the study of biology by its utility; and I shall try to point out to you that you will feel the need of some knowledge of biology at a great many turns of this present nineteenth century life of ours. For example, most of us attach great importance to the conception which we entertain of the position of man in this universe and his relation to the rest of nature. We have almost all been told, and most of us hold by the tradition, that man occupies an isolated and

peculiar position in nature; that though he is in the world he is not of the world; that his relations to things about him are of a remote character; that his origin is recent, his duration likely to be short, and that he is the great central figure round which other things in this world revolve. But this is not what the biologist tells us.

At the present moment you will be kind enough to separate me from them, because it is in no way essential to my present argument that I should advocate their views. Don't suppose that I am saying this for the purpose of escaping the responsibility of their beliefs; indeed, at other times and in other places, I do not think that point has been left doubtful; but I want clearly to point out to you that for my present argument they may all be wrong; and, nevertheless, my argument will hold good. The biologists tell us that all this is an entire mistake. They turn to the physical organisation of man. They examine his whole structure, his bony frame and all that clothes it. They resolve him into the finest particles into which the microscope will enable them to break him up. They consider the performance of his various functions and activities, and they look at the manner in which he occurs on the surface of the world. Then they turn to other animals, and taking the first handy domestic animal — say a dog — they profess to be able to demonstrate that the analysis of the dog leads them, in gross, to precisely the same results as the analysis of the man; that they find almost identically the same bones, having the same relations; that they can name the muscles of the dog by the names of the muscles of the man, and the nerves of the dog by those of the nerves of the man, and that, such structures and organs of sense as we find in the man such also we find in the dog; they analyse the brain and spinal cord and they find that the nomenclature which fits the one answers for the other. They carry their microscopic inquiries in the case of the dog as far as they can, and they find that his body is resolvable into the same elements as those of the man. Moreover, they trace back the dog's and the man's development, and they find that, at a certain stage of their existence, the two creatures are not distinguishable the one from the other; they find that the dog and his kind have a certain distribution over the surface of the world, comparable in its way to the distribution of the human species. What is true of the dog they tell us is true of all the higher animals; and they assert that they can lay down a common plan for the whole of these creatures, and regard the man and the dog, the horse and the ox as minor modifications of one great fundamental unity. Moreover, the investigations

of the last three-quarters of a century have proved, they tell us, that similar inquiries, carried out through all the different kinds of animals which are met with in nature, will lead us, not in one straight series, but by many roads, step by step, gradation by gradation, from man, at the summit, to specks of animated jelly at the bottom of the series. So that the idea of Leibnitz, and of Bonnet, that animals form a great scale of being, in which there are a series of gradations from the most complicated form to the lowest and simplest; that idea, though not exactly in the form in which it was propounded by those philosophers, turns out to be substantially correct. More than this, when biologists pursue their investigations into the vegetable world, they find that they can, in the same way, follow out the structure of the plant, from the most gigantic and complicated trees down through a similar series of gradations, until they arrive at specks of animated jelly, which they are puzzled to distinguish from those specks which they reached by the animal road.

Thus, biologists have arrived at the conclusion that a fundamental uniformity of structure pervades the animal and vegetable worlds, and that plants and animals differ from one another simply as diverse modifications of the same great general plan.

Again, they tell us the same story in regard to the study of function. They admit the large and important interval which, at the present time, separates the manifestations of the mental faculties observable in the higher forms of mankind, and even in the lower forms, such as we know them, from those exhibited by other animals; but, at the same time, they tell us that the foundations, or rudiments, of almost all the faculties of man are to be met with in the lower animals; that there is a unity of mental faculty as well as of bodily structure, and that, here also, the difference is a difference of degree and not of kind. I said "almost all," for a reason. Among the many distinctions which have been drawn between the lower creatures and ourselves, there is one which is hardly ever insisted on,* but which may be very fitly spoken of in a place so largely devoted to Art as that in which we are assembled. It is this, that while, among various kinds of animals, it is possible to discover traces of all the other faculties of man, especially the faculty of mimicry, yet that particular form of mimicry which shows itself in the imitation of form either by modelling or by drawing, is not to be met with. As far as I know, there is no sculpture or modelling, and decidedly

* I think that my friend, Professor Allman, was the first to draw attention to it.

no painting or drawing, of animal origin. I mention the fact, in order that such comfort may be derived therefrom as artists may feel inclined to take.

If what the biologists tell us is true, it will be needful to get rid of our erroneous conceptions of man, and of his place in nature, and to substitute right ones for them. But it is impossible to form any judgment as to whether the biologists are right or wrong, unless we are able to appreciate the nature of the arguments which they have to offer.

One would almost think this to be a self-evident proposition. I wonder what a scholar would say to the man who should undertake to criticise a difficult passage in a Greek play, but who obviously had not acquainted himself with the rudiments of Greek grammar. And yet, before giving positive opinions about these high questions of Biology, people not only do not seem to think it necessary to be acquainted with the grammar of the subject, but they have not even mastered the alphabet. You find criticism and denunciation showered about by persons who not only have not attempted to go through the discipline necessary to enable them to be judges, but who have not even reached that stage of emergence from ignorance in which the knowledge that such a discipline is necessary dawns upon the mind. I have had to watch with some attention — in fact I have been favoured with a good deal of it myself — the sort of criticism with which biologists and biological teachings are visited. I am told every now and then that there is a "brilliant article"* in so-and-so, in which we are all demolished. I used to read these things once, but I am getting old now, and I have ceased to attend very much to this cry of "wolf." When one does read any of these productions, what one finds generally, on the face of it is, that the brilliant critic is devoid of even the elements of biological knowledge, and that his brilliancy is like the light given out by the crackling of thorns under a pot of which Solomon speaks. So far as I recollect, Solomon makes use of the image for purposes of comparison; but I will not proceed further into that matter.

Two things must be obvious: in the first place, that every man who has the interests of truth at heart must earnestly desire that every well-founded and just criticism that can be made should be made; but that, in the second place, it is essential to anybody's being able to benefit by criticism, that the critic should know

* Galileo was troubled by a sort of people whom he called "paper philosophers," because they fancied that the true reading of nature was to be detected by the collation of texts. The race is not extinct, but, as of old, brings forth its "winds of doctrine" by which the weathercock heads among us are much exercised.

what he is talking about, and be in a position to form a mental image of the facts symbolised by the words he uses. If not, it is as obvious in the case of a biological argument, as it is in that of a historical or philological discussion, that such criticism is a mere waste of time on the part of its author, and wholly undeserving of attention on the part of those who are criticised. Take it then as an illustration of the importance of biological study, that thereby alone are men able to form something like a rational conception of what constitutes valuable criticism of the teachings of biologists.*

Next, I may mention another bearing of biological knowledge —a more practical one in the ordinary sense of the word. Consider the theory of infectious disease. Surely that is of interest to all of us. Now the theory of infectious disease is rapidly being elucidated by biological study. It is possible to produce, from among the lower animals, examples of devastating diseases which spread in the same manner as our infectious disorders, and which are certainly unmistakeably caused by living organisms. This fact renders it possible, at any rate, that that doctrine of the causation of infectious disease which is known under the name of "the germ theory" may be well-founded; and, if so, it must needs lead to the most important practical measures in dealing with those terrible visitations. It may be well that the general, as well as the professional, public should have a sufficient knowledge of biological truths to be able to take a rational interest in the discussion of such problems, and to see, what I think they may hope to see, that, to those who possess a sufficient elementary knowledge of Biology, they are not all quite open questions.

Let me mention another important practical illustration of the value of biological study. Within the last forty years the theory

* Some critics do not even take the trouble to read. I have recently been adjured with much solemnity, to state publicly why I have "changed my opinion" as to the value of the palæontological evidence of the occurrence of evolution.

To this my reply is, Why should I, when that statement was made seven years ago? An address delivered from the Presidential Chair of the Geological Society, in 1870, may be said to be a public document, inasmuch as it not only appeared in the *Journal* of that learned body, but was republished, in 1873, in a volume of *Critiques and Addresses*, to which my name is attached. Therein will be found a pretty full statement of my reasons for enunciating two propositions: (1) that "when we turn to the higher *Vertebrata*, the results of recent investigations, however we may sift and criticise them, seem to me to leave a clear balance in favour of the evolution of living forms one from another;" and (2) that the case of the horse is one which "will stand rigorous criticism."

Thus I do not see clearly in what way I can be said to have changed my opinion, except in the way of intensifying it, when in consequence of the accumulation of similar evidence since 1870, I recently spoke of the denial of evolution as not worth serious consideration.

of agriculture has been revolutionised. The researches of Liebig, and those of our own Lawes and Gilbert, have had a bearing upon that branch of industry the importance of which cannot be over-estimated; but the whole of these new views have grown out of the better explanation of certain processes which go on in plants; and which, of course, form a part of the subject-matter of Biology.

I might go on multiplying these examples, but I see that the clock won't wait for me, and I must therefore pass to the third question to which I referred:—Granted that Biology is something worth studying, what is the best way of studying it? Here I must point out that, since Biology is a physical science, the method of studying it must needs be analogous to that which is followed in the other physical sciences. It has now long been recognised that, if a man wishes to be a chemist, it is not only necessary that he should read chemical books and attend chemical lectures, but that he should actually perform the fundamental experiments in the laboratory for himself, and thus learn exactly what the words which he finds in his books and hears from his teachers, mean. If he does not do so, he may read till the crack of doom, but he will never know much about chemistry. That is what every chemist will tell you, and the physicist will do the same for his branch of science. The great changes and improvements in physical and chemical scientific education, which have taken place of late, have all resulted from the combination of practical teaching with the reading of books and with the hearing of lectures. The same thing is true in Biology. Nobody will ever know anything about Biology except in dilettante "paper-philosopher" way, who contents himself with reading books on botany, zoology, and the like; and the reason of this is simple and easy to understand. It is that all language is merely symbolical of the things of which it treats; the more complicated the things, the more bare is the symbol, and the more its verbal definition requires to be supplemented by the information derived directly from the handling, and the seeing, and the touching of the thing symbolised:—that is really what is at the bottom of the whole matter. It is plain common sense, as all truth, in the long run, is only common sense clarified. If you want a man to be a tea merchant, you don't tell him to read books about China or about tea, but you put him into a tea-merchant's office where he has the handling, the smelling, and the tasting of tea. Without the sort of knowledge which can be gained only in this practical way, his exploits as a tea merchant will soon come to a bankrupt termination. The "paper-philosophers" are under

the delusion that physical science can be mastered as literary accomplishments are acquired, but unfortunately it is not so. You may read any quantity of books, and you may be almost as ignorant as you were at starting if you don't have, at the back of your minds, the change for words in definite images which can only be acquired through the operation of your observing faculties on the phenomena of nature.

It may be said:—"That is all very well, but you told us just now that there are probably something like a quarter of a million different kinds of living and extinct animals and plants, and a human life could not suffice for the examination of one-fiftieth part of all these." That is true, but then comes the great convenience of the way things are arranged; which is, that although there are these immense numbers of different kinds of living things in existence, yet they are built up, after all, upon marvellously few plans.

There are certainly more than 100,000 species of insects, and yet anybody who knows one insect—if a properly chosen one—will be able to have a very fair conception of the structure of the whole. I do not mean to say he will know that structure thoroughly, or as well as it is desirable he should know it; but he will have enough real knowledge to enable him to understand what he reads, to have genuine images in his mind of those structures which become so variously modified in all the forms of insects he has not seen. In fact, there are such things as types of form among animals and vegetables, and for the purpose of getting a definite knowledge of what constitutes the leading modifications of animal and plant life, it is not needful to examine more than a comparatively small number of animals and plants.

Let me tell you what we do in the biological laboratory which is lodged in a building adjacent to this. There I lecture to a class of students daily for about four-and-a-half months, and my class have, of course, their text-books; but the essential part of the whole teaching, and that which I regard as really the most important part of it, is a laboratory for practical work, which is simply a room with all the appliances needed for ordinary dissection. We have tables properly arranged in regard to light, microscopes, and dissecting instruments, and we work through the structure of a certain number of animals and plants. As, for example, among the plants, we take a yeast plant, a *Protococcus,* a common mould, a *Chara,* a fern, and some flowering plant; among animals we examine such things as an *Amœba,* a *Vorticella,* and a fresh-water polype. We dissect a star-fish, an

earth-worm, a snail, a squid, and a fresh-water mussel. We examine a lobster and a cray-fish, and a black beetle. We go on to a common skate, a cod-fish, a frog, a tortoise, a pigeon, and a rabbit, and that takes us about all the time we have to give. The purpose of this course is not to make skilled dissectors, but to give every student a clear and definite conception, by means of sense-images, of the characteristic structure of each of the leading modifications of the animal kingdom; and that is perfectly possible, by going no further than the length of that list of forms which I have enumerated. If a man knows the structure of the animals I have mentioned, he has a clear and exact, however limited, apprehension of the essential features of the organisation of all those great divisions of the animal and vegetable kingdoms to which the forms I have mentioned severally belong. And it then becomes possible for him to read with profit; because every time he meets with the name of a structure, he has a definite image in his mind of what the name means in the particular creature he is reading about, and therefore the reading is not mere reading. It is not mere repetition of words; but every term employed in the description, we will say, of a horse, or of an elephant, will call up the image of the things he had seen in the rabbit, and he is able to form a distinct conception of that which he has not seen, as a modification of that which he has seen.

I find this system to yield excellent results; and I have no hesitation whatever in saying, that any one who has gone through such a course, attentively, is in a better position to form a conception of the great truths of Biology, especially of morphology (which is what we chiefly deal with), than if he had merely read all the books on that topic put together.

The connection of this discourse with the Loan Collection of Scientific Apparatus arises out of the exhibition in that collection of certain aids to our laboratory work. Such of you as have visited that very interesting collection may have noticed a series of diagrams and of preparations illustrating the structure of a frog. Those diagrams and preparations have been made for the use of the students in the biological laboratory. Similar diagrams and preparations illustrating the structure of all the other forms of life we examine, are either made or in course of preparation. Thus the student has before him, first, a picture of the structure he ought to see; secondly, the structure itself worked out; and if with these aids, and such needful explanations and practical hints as a demonstrator can supply, he cannot make out the facts

for himself in the materials supplied to him, he had better take to some other pursuit than that of biological science.

I should have been glad to have said a few words about the use of museums in the study of Biology, but I see that my time is becoming short, and I have yet another question to answer. Nevertheless, I must, at the risk of wearying you, say a word or two upon the important subject of museums. Without doubt there are no helps to the study of Biology, or rather to some branches of it, which are, or may be, more important than natural history museums; but, in order to take this place in regard to Biology, they must be museums of the future. The museums of the present do not, by any means, do so much for us as they might do. I do not wish to particularise, but I dare say many of you, seeking knowledge, or in the laudable desire to employ a holiday usefully, have visited some great natural history museum. You have walked through a quarter of a mile of animals, more or less well stuffed, with their long names written out underneath them! and, unless your experience is very different from that of most people, the upshot of it all is that you leave that splendid pile with sore feet, a bad headache, and a general idea that the animal kingdom is a "mighty maze without a plan." I do not think that a museum which brings about this result does all that may be reasonably expected from such an institution. What is needed in a collection of natural history is that it should be made as accessible and as useful as possible, on the one hand to the general public, and on the other to scientific workers. That need is not met by constructing a sort of happy hunting-ground of miles of glass cases; and, under the pretence of exhibiting everything putting the maximum amount of obstacle in the way of those who wish properly to see anything.

What the public want is easy and unhindered access to such a collection as they can understand and appreciate; and what the men of science want is similar access to the materials of science. To this end the vast mass of objects of natural history should be divided into two parts — one open to the public, the other to men of science, every day. The former division should exemplify all the more important and interesting forms of life. Explanatory tablets should be attached to them, and catalogues containing clearly-written popular expositions of the general significance of the objects exhibited should be provided. The latter should contain, packed into a comparatively small space, in rooms adapted for working purposes, the objects of purely scientific interest. For example, we will say I am an ornithologist. I go to examine a collection of birds. It is a positive nuisance to have them

stuffed. It is not only sheer waste, but I have to reckon with the ideas of the bird-stuffer, while, if I have the skin and nobody has interfered with it, I can form my own judgment as to what the bird was like. For ornithological purposes, what is needed is not glass cases full of stuffed birds on perches, but convenient drawers into each of which a great quantity of skins will go. They occupy no great space and do not require any expenditure beyond their original cost. But for the edification of the public, who want to learn indeed, but do not seek for minute and technical knowledge, the case is different. What one of the general public walking into a collection of birds desires to see is not all the birds that can be got together. He does not want to compare a hundred species of the sparrow tribe side by side; but he wishes to know what a bird is, and what are the great modifications of bird structure, and to be able to get at that knowledge easily. What will best serve his purpose is a comparatively small number of birds carefully selected, and artistically, as well as accurately, set up; with their different ages, their nests, their young, their eggs, and their skeletons side by side; and in accordance with the admirable plan which is pursued in this museum, a tablet, telling the spectator in legible characters what they are and what they mean. For the instruction and recreation of the public such a typical collection would be of far greater value than any many-acred imitation of Noah's ark.

Lastly comes the question as to when biological study may best be pursued. I do not see any valid reason why it should not be made, to a certain extent, a part of ordinary school training. I have long advocated this view, and I am perfectly certain that it can be carried out with ease, and not only with ease, but with very considerable profit to those who are taught; but then such instruction must be adapted to the minds and needs of the scholars. They used to have a very odd way of teaching the classical languages when I was a boy. The first task set you was to learn the rules of the Latin grammar in the Latin language —that being the language you were going to learn! I thought then that this was an odd way of learning a language, but did not venture to rebel against the judgment of my superiors. Now, perhaps, I am not so modest as I was then, and I allow myself to think that it was a very absurd fashion. But it would be no less absurd, if we were to set about teaching Biology by putting it into the hands of boys a series of definitions of the classes and orders of the animal kingdom, and making them repeat them by heart. That is so very favourite a method of teaching, that I sometimes fancy the spirit of the old classical system has entered

into the new scientific system, in which case I would much rather that any pretence at scientific teaching were abolished altogether. What really has to be done is to get into the young mind some notion of what animal and vegetable life is. In this matter, you have to consider practical convenience as well as other things. There are difficulties in the way of a lot of boys making messes with slugs and snails; it might not work in practice. But there is a very convenient and handy animal which everybody has at hand, and that is himself; and it is a very easy and simple matter to obtain common plants. Hence the general truths of anatomy and physiology can be taught to young people in a very real fashion by dealing with the broad facts of human structure. Such viscera as they cannot very well examine in themselves, such as hearts, lungs, and livers, may be obtained from the nearest butcher's shop. In respect to teaching something about the biology of plants, there is no practical difficulty, because almost any of the common plants will do, and plants do not make a mess — at least they do not make an unpleasant mess; so that, in my judgment, the best form of Biology for teaching to very young people is elementary human physiology on the one hand, and the elements of botany on the other; beyond that I do not think it will be feasible to advance for some time to come. But then I see no reason, why, in secondary schools, and in the Science Classes which are under the control of the Science and Art Department — and which I may say, in passing, have in my judgment, done so very much for the diffusion of a knowledge of science over the country — we should not hope to see instruction in the elements of Biology carried out, not perhaps to the same extent, but still upon somewhat the same principle as here. There is no difficulty, when you have to deal with students of the ages of fifteen or sixteen, in practising a little dissection and in getting a notion of, at any rate, the four or five great modifications of the animal form; and the like is true in regard to the higher anatomy of plants.

While, lastly, to all those who are studying biological science with a view to their own edification merely, or with the intention of becoming zoologists or botanists; to all those who intend to pursue physiology — and especially to those who propose to employ the working years of their lives in the practice of medicine — I say that there is no training so fitted, or which may be of such important service to them, as the discipline in practical biological work which I have sketched out as being pursued in the laboratory hard by.

I may add that, beyond all these different classes of persons who may profit by the study of Biology, there is yet one other. I remember, a number of years ago, that a gentleman who was a vehement opponent of Mr. Darwin's views and had written some terrible articles against them, applied to me to know what was the best way in which he could acquaint himself with the strongest arguments in favour of evolution. I wrote back, in all good faith and simplicity, recommending him to go through a course of comparative anatomy and physiology, and then to study development. I am sorry to say he was very much displeased, as people often are with good advice. Notwithstanding this discouraging result, I venture, as a parting word, to repeat the suggestion, and to say to all the more or less acute lay and clerical "paper-philosophers" * who venture into the regions of biological controversy — Get a little sound, thorough, practical, elementary instruction in biology.

* Writers of this stamp are fond of talking about the Baconian method. I beg them therefore to lay to heart these two weighty sayings of the herald of Modern Science :—

"Syllogismus ex propositionibus constat, propositiones ex verbis, verba notionum tesseræ sunt. Itaque si notiones ipsæ (*id quod basis rei est*) confusæ sint et temere a rebus abstractæ, nihil in iis quæ superstruuntur est firmitudinis."— *Novum Organon*, ii. 14.

"Huic autem vanitati nonnulli ex modernis summa levitate ita indulserunt, ut in primo capitulo Geneseos et in libro Job et aliis scripturis sacris, philosophiam naturalem fundare conhei sint; *inter vivos quærentes mortua*." — *Ibid.* 65.

XI.

ON ELEMENTARY INSTRUCTION IN PHYSIOLOGY.

THE chief ground upon which I venture to recommend that the teaching of elementary physiology should form an essential part of an organised course of instruction in matter pertaining to domestic economy, is, that a knowledge of even the elements of this subject supplies those conceptions of the constitution and mode of action of the living body, and of the nature of health and disease, which prepare the mind to receive instruction from sanitary science.

It is, I think, eminently desirable that the hygienist and the physician should find something in the public mind to which they can appeal; some little stock of universally acknowledged truths, which may serve as a foundation for their warnings, and predispose towards an intelligent obedience to their recommendations.

Listening to ordinary talk about health, disease, and death, one is often led to entertain a doubt whether the speakers believe that the course of natural causation runs as smoothly in the human body as elsewhere. Indications are too often obvious of a strong, though perhaps an unavowed and half unconscious, under-current of opinion that the phenomena of life are not only widely different, in their superficial characters and in their practical importance, from other natural events, but that they do not follow in that definite order which characterises the succession of all other occurrences, and the statement of which we call a law of nature.

Hence, I think, arises the want of heartiness of belief in the value of knowledge respecting the laws of health and disease, and of the foresight and care to which knowledge is the essential preliminary, which is so often noticeable; and a corresponding laxity and carelessness in practice, the results of which are too frequently lamentable.

It is said that among the many religious sects of Russia, there is one which holds that all disease is brought about by the direct and special interference of the Deity, and which, therefore, looks

with repugnance upon both preventive and curative measures as alike blasphemous interferences with the will of God. Among ourselves, the "Peculiar People" are, I believe, the only persons who hold the like doctrine in its integrity, and carry it out with logical rigour. But many of us are old enough to recollect that the administration of chloroform in assuagement of the pangs of childbirth was, at its introduction, strenuously resisted upon similar grounds.

I am not sure that the feeling, of which the doctrine to which I have referred is the full expression, does not lie at the bottom of the minds of a great many people who yet would vigorously object to give a verbal assent to the doctrine itself. However this may be, the main point is that sufficient knowledge has now been acquired of vital phenomena, to justify the assertion, that the notion, that there is anything exceptional about these phenomena, receives not a particle of support from any known fact. On the contrary, there is a vast and an increasing mass of evidence that birth and death, health and disease, are as much parts of the ordinary stream of events as the rising and setting of the sun, or the changes of the moon; and that the living body is a mechanism, the proper working of which we term health; its disturbance, disease; its stoppage, death. The activity of this mechanism is dependent upon many and complicated conditions, some of which are hopelessly beyond our control, while others are readily accessible, and are capable of being indefinitely modified by our own actions. The business of the hygienist and of the physician is to know the range of these modifiable conditions, and how to influence them towards the maintenance of health and the prolongation of life; the business of the general public is to give an intelligent assent, and a ready obedience based upon that assent, to the rules laid down for their guidance by such experts. But an intelligent assent is an assent based upon knowledge, and the knowledge which is here in question means an acquaintance with the elements of physiology.

It is not difficult to acquire such knowledge. What is true, to a certain extent, of all the physical sciences, is eminently characteristic of physiology — the difficulty of the subject begins beyond the stage of elementary knowledge, and increases with every stage of progress. While the most highly trained and the best furnished intellect may find all its resources insufficient, when it strives to reach the heights and penetrate into the depths of the problems of physiology, the elementary and fundamental truths can be made clear to a child.

No one can have any difficulty in comprehending the mechanism

of circulation or respiration; or the general mode of operation of the organ of vision; though the unravelling of all the minutiæ of these processes, may, for the present, baffle the conjoined attacks of the most accomplished physicists, chemists, and mathematicians. To know the anatomy of the human body, with even an approximation to thoroughness, is the work of a life; but as much as is needed for a sound comprehension of elementary physiological truths, may be learned in a week.

A knowledge of the elements of physiology is not only easy of acquirement, but it may be made a real and practical acquaintance with the facts, as far as it goes. The subject of study is always at hand, in one's self. The principal constituents of the skeleton, and the changes of form of contracting muscles, may be felt through one's own skin. The beating of one's heart, and its connection with the pulse, may be noted; the influence of the valves of one's own veins may be shown; the movements of respiration may be observed; while the wonderful phenomena of sensation afford an endless field for curious and interesting self-study. The prick of a needle will yield, in a drop of one's own blood, material for microscopic observation of phenomena which lie at the foundation of all biological conceptions; and a cold, with its concomitant coughing and sneezing, may prove the sweet uses of adversity by helping one to a clear conception of what is meant by "reflex action."

Of course there is a limit to this physiological self-examination. But there is so close a solidarity between ourselves and our poor relations of the animal world, that our inaccessible inward parts may be supplemented by theirs. A comparative anatomist knows that a sheep's heart and lungs, or eye, must not be confounded with those of a man; but, so far as the comprehension of the elementary facts of the physiology of circulation, of respiration, and of vision goes, the one furnishes the needful anatomical data as well as the other.

Thus, it is quite possible to give instruction in elementary physiology in such a manner as, not only to confer knowledge, which, for the reason I have mentioned, is useful in itself; but to serve the purposes of a training in accurate observation, and in the methods of reasoning of physical science. But that is an advantage which I mention only incidentally, as the present Conference does not deal with education in the ordinary sense of the word.

It will not be suspected that I wish to make physiologists of all the world. It would be as reasonable to accuse an advocate of the "three R's" of a desire to make an orator, an author, and

a mathematician of everybody. A stumbling reader, a pot-hook writer, and an arithmetician who has not got beyond the rule of three, is not a person of brilliant acquirements; but the difference between such a member of society and one who can neither read, write, nor cipher is almost inexpressible; and no one nowadays doubts the value of instruction, even if it goes no farther.

The saying that a little knowledge is a dangerous thing is, to my mind, a very dangerous adage. If knowledge is real and genuine, I do not believe that it is other than a very valuable possession, however infinitesimal its quantity may be. Indeed, if a little knowledge is dangerous, where is the man who has so much as to be out of danger?

If William Harvey's life-long labours had revealed to him a tenth part of that which may be made sound and real knowledge to our boys and girls, he would not only have been what he was, the greatest physiologist of his age, but he would have loomed upon the seventeenth century as a sort of intellectual portent. Our "little knowledge" would have been to him a great, astounding, unlooked-for vision of scientific truth.

I really see no harm which can come of giving our children a little knowledge of physiology. But then, as I have said, the instruction must be real, based upon observation, eked out by good explanatory diagrams and models, and conveyed by a teacher whose own knowledge has been acquired by a study of the facts; and not the mere catechismal parrot-work which too often usurps the place of elementary teaching.

It is, I hope, unnecessary for me to give a formal contradiction to the silly fiction, which is assiduously circulated by fanatics who not only ought to know, but do know, that their assertions are untrue, that I have advocated the introduction of that experimental discipline which is absolutely indispensable to the professed physiologist, into elementary teaching.

But while I should object to any experimentation which can justly be called painful, for the purpose of elementary instruction; and, while, as a member of the late Royal Commission, I gladly did my best to prevent the infliction of needless pain, for any purpose; I think it is my duty to take this opportunity of expressing my regret at a condition of the law which permits a boy to troll for pike, or set lines with live-frog bait, for idle amusement; and, at the same time, lays the teacher of that boy open to the penalty of fine and imprisonment, if he uses the same animal for the purpose of exhibiting one of the most beautiful and instructive of physiological spectacles, the circulation in the web of the foot. No one could undertake to affirm that

a frog is not inconvenienced by being wrapped up in a wet rag, and having his toes tied out; and it cannot be denied that inconvenience is a sort of pain. But you must not inflict the least pain on a vertebrated animal for scientific purposes (though you may do a good deal in that way for gain or for sport) without due licence of the Secretary of State for the Home Department, granted under the authority of the Vivisection Act.

So it comes about, that, in this present year of grace 1877, two persons may be charged with cruelty to animals. One has impaled a frog, and suffered the creature to writhe about in that condition for hours; the other has pained the animal no more than one of us would be pained by tying strings round his fingers, and keeping him in the position of a hydropathic patient. The first offender says "I did it because I find fishing very amusing," and the magistrate bids him depart in peace; nay, probably wishes him good sport. The second pleads, "I wanted to impress a scientific truth, with a distinctness attainable in no other way, on the minds of my scholars," and the magistrate fines him five pounds.

I cannot but think that this is an anomalous and not wholly creditable state of things.

XII.

ON MEDICAL EDUCATION.*

IT has given me sincere pleasure to be here to-day, at the desire of your highly respected President and the Council of the College. In looking back upon my own past, I am sorry to say that I have found that it is a quarter of a century since I took part in those hopes and in those fears by which you have all recently been agitated, and which now are at an end. But, although so long a time has elapsed since I was moved by the same feelings, I beg leave to assure you that my sympathy with both victors and vanquished remains fresh — so fresh, indeed, that I could almost try to persuade myself that, after all, it cannot be so very long ago. My business during the last hour, however, has been to show that sympathy with one side only, and I assure you I have done my best to play my part heartily, and to rejoice in the success of those who have succeeded. Still, I should like to remind you at the end of it all, that success on an occasion of this kind, valuable and important as it is, is in reality only putting the foot upon one rung of the ladder which leads upwards; and that the rung of a ladder was never meant to rest upon, but only to hold a man's foot long enough to enable him to put the other somewhat higher. I trust that you will all regard these successes as simply reminders that your next business is, having enjoyed the success of the day, no longer to look at that success, but to look forward to the next difficulty that is to be conquered. And now, having had so much to say to the successful candidates, you must forgive me if I add that a sort of undercurrent of sympathy has been going on in my mind all the time for those who have not been successful, for those valiant knights who have been overthrown in your tourney, and have not made their appearance in public. I trust that, in accordance with old custom, they, wounded and bleeding, have been carried off to their tents, to be carefully tended by the fairest of maidens; and in these days, when the chances are that every one of such maidens will be a qualified practitioner, I have no doubt that all the splinters

*Address to the students of the Faculty of Medicine, University College, London.

will have been carefully extracted, and that they are now physically healed. But there may remain some little fragment of moral or intellectual discouragement, and therefore I will take the liberty to remark that your chairman to-day, if he occupied his proper place, would be among them. Your chairman, in virtue of his position, and for the brief hour that he occupies that position, is a person of importance; and it may be some consolation to those who have failed if I say, that the quarter of a century which I have been speaking of, takes me back to the time when I was up at the University of London, a candidate for honours in anatomy and physiology, and when I was exceedingly well beaten by my excellent friend, Dr. Ransom, of Nottingham. There is a person here who recollects that circumstance very well. I refer to your venerated teacher and mine, Dr. Sharpey. He was at that time one of the examiners in anatomy and physiology, and you may be quite sure that, as he was one of the examiners, there remained not the smallest doubt in my mind of the propriety of his judgment, and I accepted my defeat with the most comfortable assurance that I had thoroughly well earned it. But, gentlemen, the competitor having been a worthy one, and the examination a fair one, I cannot say that I found in that circumstance anything very discouraging. I said to myself, "Never mind; what's the next thing to be done?" And I found that policy of "never minding" and going on to the next thing to be done, to be the most important of all policies in the conduct of practical life. It does not matter how many tumbles you have in this life, so long as you do not get dirty when you tumble; it is only the people who have to stop to be washed and made clean, who must necessarily lose the race. And I can assure you that there is the greatest practical benefit in making a few failures early in life. You learn that which is of inestimable importance — that there are a great many people in the world who are just as clever as you are. You learn to put your trust, by and by, in an economy and frugality of the exercise of your powers, both moral and intellectual; and you very soon find out, if you have not found it out before, that patience and tenacity of purpose are worth more than twice their weight of cleverness. In fact, if I were to go on discoursing on this subject, I should become almost eloquent in praise of non-success; but, lest so doing should seem, in any way, to wither well-earned laurels, I will turn from that topic, and ask you to accompany me in some considerations touching another subject which has a very profound interest for me, and which I think ought to have an equally profound interest for you.

I presume that the great majority of those whom I address propose to devote themselves to the profession of medicine; and I do not doubt, from the evidences of ability which have been given to-day, that I have before me a number of men who will rise to eminence in that profession, and who will exert a great and deserved influence upon its future. That in which I am interested, and about which I wish to speak, is the subject of medical education, and I venture to speak about it for the purpose, if I can, of influencing you, who may have the power of influencing the medical education of the future. You may ask, by what authority do I venture, being a person not concerned in the practice of medicine, to meddle with that subject? I can only tell you it is a fact, of which a number of you I dare say are aware by experience (and I trust the experience has no painful associations), that I have been for a considerable number of years (twelve or thirteen years at the best of my recollection) one of the examiners in the University of London. You are further aware that the men who come up to the University of London are the picked men of the medical schools of London, and therefore such observations as I may have to make upon the state of knowledge of these gentlemen, if they be justified, in regard to any faults I may have to find, cannot be held to indicate defects in the capacity, or in the power of application of those gentlemen, but must be laid, more or less, to the account of the prevalent system of medical education. I will tell you what has struck me — but in speaking in this frank way, as one always does about the defects of one's friends, I must beg you to disabuse your minds of the notion that I am alluding to any particular school, or to any particular college, or to any particular person; and to believe that if I am silent when I should be glad to speak with high praise, it is because that praise would come too close to this locality. What has struck me, then, in this long experience of the men best instructed in physiology from the medical schools of London is (with the many and brilliant exceptions to which I have referred), taking it as a whole, and broadly, the singular unreality of their knowledge of physiology. Now, I use that word "unreality" advisedly: I do not say "scanty;" on the contrary, there is plenty of it — a great deal too much of it — but it is the quality, the nature of the knowledge, which I quarrel with. I know I used to have — I don't know whether I have now, but I had once upon a time — a bad reputation among students for setting up a very high standard of acquirement, and I dare say you may think that the standard of this old examiner, who happily is now very nearly an extinct examiner, has been pitched too high.

Nothing of the kind, I assure you. The defects I have noticed, and the faults I have to find, arise entirely from the circumstance that my standard is pitched too low. This is no paradox, gentlemen, but quite simply the fact. The knowledge I have looked for was a real, precise, thorough, and practical knowledge of fundamentals; whereas that which the best of the candidates, in a large proportion of cases, have had to give me was a large, extensive, and inaccurate knowledge of superstructure; and that is what I mean by saying that my demands went too low and not too high. What I have had to complain of is, that a large proportion of the gentlemen who come up for physiology to the University of London do not know it as they know their anatomy, and have not been taught it as they have been taught their anatomy. Now, I should not wonder at all if I heard a great many "No, noes" here; but I am not talking about University College; as I have told you before, I am talking about the average education of medical schools. What I have found, and found so much reason to lament, is, that while anatomy has been taught as a science ought to be taught, as a matter of autopsy, and observation, and strict discipline; in a very large number of cases, physiology has been taught as if it were a mere matter of books and of hearsay. I declare to you, gentlemen, that I have often expected to be told, when I have asked a question about the circulation of the blood, that Professor Breitkopf is of opinion that it circulates, but that the whole thing is an open question. I assure you that I am hardly exaggerating the state of mind on matters of fundamental importance which I have found over and over again to obtain among gentlemen coming up to that picked examination of the University of London. Now, I do not think that is a desirable state of things. I cannot understand why physiology should not be taught — in fact, you have here abundant evidence that it can be taught — with the same definiteness and the same precision as anatomy is taught. And you may depend upon this, that the only physiology which is to be of any good whatever in medical practice, or in its application to the study of medicine, is that physiology which a man knows of his own knowledge; just as the only anatomy which would be of any good to the surgeon is the anatomy which he knows of his own knowledge. Another peculiarity I have found in the physiology which has been current, and that is, that in the minds of a great many gentlemen it has been supplanted by histology. They have learnt a great deal of histology, and they have fancied that histology and physiology are the same things. I have asked for some knowledge of the physics and the mechanics and the chemistry of the human body, and I

have been met by talk about cells. I declare to you I believe it will take me two years, at least, of absolute rest from the business of an examiner to hear the word "cell," "germinal matter," or "carmine," without a sort of inward shudder.

Well, now, gentlemen, I am sure my colleagues in this examination will bear me out in saying that I have not been exaggerating the evils and defects which are current — have been current — in a large quantity of the physiological teaching the results of which come before examiners. And it becomes a very interesting question to know how all this comes about, and in what way it can be remedied. How it comes about will be perfectly obvious to any one who has considered the growth of medicine. I suppose that medicine and surgery first began by some savage more intelligent than the rest, discovering that a certain herb was good for a certain pain, and that a certain pull, somehow or other, set a dislocated joint right. I suppose all things had their humble beginnings, and medicine and surgery were in the same condition. People who wear watches know nothing about watchmaking. A watch goes wrong and it stops; you see the owner giving it a shake, or, if he is very bold, he opens the case, and gives the balance-wheel a push. Gentlemen, that is empirical practice, and you know what are the results upon the watch. I should think you can divine what are the results of analogous operations upon the human body. And because men of sense very soon found that such were the effects of meddling with very complicated machinery they did not understand, I suppose the first thing, as being the easiest, was to study the nature of the works of the human watch, and the next thing was to study the way the parts worked together, and the way the watch worked. Thus, by degrees, we have had growing up our body of anatomists, or knowers of the construction of the human watch, and our physiologists, who know how the machine works. And just as any sensible man, who has a valuable watch, does not meddle with it himself, but goes to some one who has studied watchmaking, and understands what the effect of doing this or that may be; so, I suppose, the man who, having charge of that valuable machine, his own body, wants to have it kept in good order, comes to a professor of the medical art for the purpose of having it set right, believing that, by deduction from the facts of structure and from the facts of function, the physician will divine what may be the matter with his bodily watch at that particular time, and what may be the best means of setting it right. If that may be taken as a just representation of the relation of the theoretical branches of medicine — what we may call the institutes of medicine, to use an old term —

to the practical branches, I think it will be obvious to you that they are of prime and fundamental importance. Whatever tends to affect the teaching of them injuriously must tend to destroy and to disorganise the whole fabric of the medical art. I think every sensible man has seen this long ago; but the difficulties in the way of attaining good teaching in the different branches of the theory, or institutes, of medicine are very serious. It is a comparatively easy matter — pray mark that I use the word "comparatively" — it is a comparatively easy matter to learn anatomy and to teach it. It is a very difficult matter to learn physiology and to teach it. It is a very difficult matter to know and to teach those branches of physics and those branches of chemistry which bear directly upon physiology; and hence it is that, as a matter of fact, the teaching of physiology, and the teaching of the physics and the chemistry which bear upon it, must necessarily be in a state of relative imperfection; and there is nothing to be grumbled at in the fact that this relative imperfection exists. But is the relative imperfection which exists only such as is necessary, or is it made worse by our practical arrangements? I believe — and if I did not so believe I should not have troubled you with these observations — I believe it is made infinitely worse by our practical arrangements, or rather, I ought to say, our very unpractical arrangements. Some very wise man long ago affirmed that every question, in the long run, was a question of finance; and there is a good deal to be said for that view. Most assuredly the question of medical teaching is, in a very large and broad sense, a question of finance. What I mean is this: that in London the arrangements of the medical schools, and the number of them, are such as to render it almost impossible that men who confine themselves to the teaching of the theoretical branches of the profession should be able to make their bread by that operation; and, you know, if a man cannot make his bread he cannot teach — at least his teaching comes to a speedy end. That is a matter of physiology. Anatomy is fairly well taught, because it lies in the direction of practice, and a man is all the better surgeon for being a good anatomist. It does not absolutely interfere with the pursuits of a practical surgeon if he should hold a Chair of Anatomy — though I do not for one moment say that he would not be a better teacher if he did not devote himself to practice. (Applause.) Yes, I know exactly what that cheer means, but I am keeping as carefully as possible from any sort of allusion to Professor Ellis. But the fact is, that even human anatomy has now grown to be so large a matter, that it takes the whole devotion of a man's life to put the great mass of knowledge upon that subject into such a shape that

it can be teachable to the mind of the ordinary student. What the student wants in a professor is a man who shall stand between him and the infinite diversity and variety of human knowledge, and who shall gather all that together, and extract from it that which is capable of being assimilated by the mind. That function is a vast and an important one, and unless, in such subjects as anatomy, a man is wholly free from other cares, it is almost impossible that he can perform it thoroughly and well. But if it be hardly possible for a man to pursue anatomy without actually breaking with his profession, how is it possible for him to pursue physiology?

I get every year those very elaborate reports of Henle and Meissner — volumes of, I suppose, 400 pages altogether — and they consist merely of abstracts of the memoirs and works which have been written on Anatomy and Physiology — only abstracts of them! How is a man to keep up his acquaintance with all that is doing in the physiological world — in a world advancing with enormous strides every day and every hour — if he has to be distracted with the cares of practice? You know very well it must be impracticable to do so. Our men of ability join our medical schools with an eye to the future. They take the Chairs of Anatomy or of Physiology; and by and by they leave those Chairs for the more profitable pursuits into which they have drifted by professional success, and so they become clothed, and physiology is bare. The result is, that in those schools in which physiology is thus left to the benevolence, so to speak, of those who have no time to look to it, the effect of such teaching comes out obviously, and is made manifest in what I spoke of just now — the unreality, the bookishness of the knowledge of the taught. And if this is the case in physiology, still more must it be the case in those branches of physics which are the foundation of physiology; although it may be less the case in chemistry, because for an able chemist a certain honourable and independent career lies in the direction of his work, and he is able, like the anatomist, to look upon what he may teach to the student as not absolutely taking him away from his bread-winning pursuits.

But it is of no use to grumble about this state of things unless one is prepared to indicate some sort of practical remedy. And I believe — and I venture to make the statement because I am wholly independent of all sorts of medical schools, and may, therefore, say what I believe without being supposed to be affected by any personal interest — but I say I believe that the remedy for this state of things, for that imperfection of our theoretical knowledge which keeps down the ability of England at the present time

in medical matters, is a mere affair of mechanical arrangement; that so long as you have a dozen medical schools scattered about in different parts of the metropolis, and dividing the students among them, so long, in all the smaller schools at any rate, it is impossible that any other state of things than that which I have been depicting should obtain. Professors must live; to live they must occupy themselves with practice, and if they occupy themselves with practice, the pursuit of the abstract branches of science must go to the wall. All this is a plain and obvious matter of common-sense reasoning. I believe you will never alter this state of things until, either by consent or by *force majeure* — and I should be very sorry to see the latter applied — but until there is some new arrangement, and until all the theoretical branches of the profession, the institutes of medicine, are taught in London in not more than one or two, or at the outside three, central institutions, no good will be effected. If that large body of men, the medical students of London, were obliged in the first place to get a knowledge of the theoretical branches of their profession in two or three central schools, there would be abundant means for maintaining able professors — not, indeed, for enriching them, as they would be able to enrich themselves by practice — but for enabling them to make that choice which such men are so willing to make; namely, the choice between wealth and a modest competency, when that modest competency is to be combined with a scientific career, and the means of advancing knowledge. I do not believe that all the talking about, and tinkering of, medical education will do the slighest good until the fact is clearly recognised, that men must be thoroughly grounded in the theoretical branches of their profession, and that to this end the teaching of those theoretical branches must be confined to two or three centres.

Now let me add one other word, and that is, that if I were a despot, I would cut down these branches to a very considerable extent. The next thing to be done beyond that which I mentioned just now, is to go back to primary education. The great step towards a thorough medical education is to insist upon the teaching of the elements of the physical sciences in all schools, so that medical students shall not go up to the medical colleges utterly ignorant of that with which they have to deal; to insist on the elements of chemistry, the elements of botany, and the elements of physics being taught in our ordinary and common schools, so that there shall be some preparation for the discipline of medical colleges. And, if this reform were once effected, you might confine the "Institutes of Medicine" to physics as applied to physiology — to chemistry as applied to physiology — to physiology itself, and to

anatomy. Afterwards, the student, thoroughly grounded in these matters, might go to any hospital he pleased for the purpose of studying the practical branches of his profession. The practical teaching might be made as local as you like; and you might use to advantage the opportunities afforded by all these local institutions for acquiring a knowledge of the practice of the profession. But you may say: "This is abolishing a great deal; you are getting rid of botany and zoology to begin with." I have not a doubt that they ought to be got rid of, as branches of special medical education; they ought to be put back to an earlier stage, and made branches of general education. Let me say, by way of self-denying ordinance, for which you will, I am sure, give me credit, that I believe that comparative anatomy ought to be absolutely abolished. I say so, not without a certain fear of the Vice-Chancellor of the University of London who sits upon my left. But I do not think the charter gives him very much power over me; moreover, I shall soon come to an end of my examinership, and therefore, I am not afraid, but shall go on to say what I was going to say, and that is, that in my belief it is a downright cruelty — I have no other word for it — to require from gentlemen who are engaged in medical studies, the pretence — for it is nothing else, and can be nothing else, than a pretence — of a knowledge of comparative anatomy as part of their medical curriculum. Make it part of their Arts teaching if you like, make it part of their general education if you like, make it part of their qualification for the scientific degree by all means — that is its proper place; but to require that gentlemen whose whole faculties should be bent upon the acquirement of a real knowledge of human physiology should worry themselves with getting up hearsay about the alternation of generations in the Salpæ is really monstrous. I cannot characterise it in any other way. And having sacrificed my own pursuit, I am sure I may sacrifice other people's; and I make this remark with all the more willingness because I discovered, on reading the names of your Professors just now, that the Professor of Materia Medica is not present. I must confess, if I had my way I should abolish Materia Medica* altogether. I recollect, when I was first under examination at the University of London, Dr. Pereira was the examiner, and you know that Pereira's "Materia Medica" was a book *de omnibus rebus*. I recollect my struggles with that book late at night and early in the morning (I worked very hard in those days), and I do believe that I got that book into my head somehow or other, but then I

* It will, I hope, be understood that I do not include Therapeutics under this head.

will undertake to say that I forgot it all a week afterwards. Not one trace of a knowledge of drugs has remained in my memory from that time to this; and really, as a matter of common sense, I cannot understand the arguments for obliging a medical man to know all about drugs and where they come from. Why not make him belong to the Iron and Steel Institute, and learn something about cutlery, because he uses knives?

But do not suppose that, after all these deductions, there would not be ample room for your activity. Let us count up what we have left. I suppose all the time for medical education that can be hoped for is, at the outside, about four years. Well, what have you to master in those four years upon my supposition? Physics applied to physiology; chemistry applied to physiology; physiology; anatomy; surgery; medicine (including therapeutics); obstetrics; hygiene; and medical jurisprudence—nine subjects for four years! And when you consider what those subjects are, and that the acquisition of anything beyond the rudiments of any one of them may tax the energies of a lifetime, I think that even those energies which you young gentlemen have been displaying for the last hour or two might be taxed to keep you thoroughly up to what is wanted for your medical career.

I entertain a very strong conviction that any one who adds to medical education one iota or tittle beyond what is absolutely necessary, is guilty of a very grave offence. Gentlemen, it will depend upon the knowledge that you happen to possess,—upon your means of applying it within your own field of action,—whether the bills of mortality in your district are increased or diminished; and that, gentlemen, is a very serious consideration indeed. And, under those circumstances, the subjects with which you have to deal being so difficult, their extent so enormous, and the time at your disposal so limited, I could not feel my conscience easy if I did not, on such an occasion as this, raise a protest against employing your energies upon the acquisition of any knowledge which may not be absolutely needed in your future career.

XIII.

THE STATE AND THE MEDICAL PROFESSION.

AT intervals during the last quarter of a century committees of the Houses of the Legislature and specially appointed commissions have occupied themselves with the affairs of the medical profession. Much evidence has been taken, much wrangling has gone on over the reports of these bodies; and sometimes much trouble has been taken to get measures based upon all this work through Parliament, but very little has been achieved.

The Bill introduced last session was not more fortunate than several predecessors. I suppose that it is not right to rejoice in the misfortunes of anything, even a Bill; but I confess that this event afforded me lively satisfaction, for I was a member of the Royal Commission on the report of which the Bill was founded, and I did my best to oppose and nullify that report.

That the question must be taken up again and finally dealt with by the Legislature before long cannot be doubted; but in the meanwhile there is time for reflection, and I think that the non-medical public would be wise if they paid a little attention to a subject which is really of considerable importance to them.

The first question which a plain man is disposed to ask himself is, Why should the State interfere with the profession of medicine any more than it does, say, with the profession of engineering? Anybody who pleases may call himself an engineer, and may practice as such. The State confers no title upon engineers, and does not profess to tell the public that one man is a qualified engineer and that another is not so.

The answers which are given to the question are various, and most of them, I think, are bad. A large number of persons seem to be of opinion that the State is bound no less to take care of the general public, than to see that it is protected against incompetent persons, against quacks and medical impostors in general. I do not take that view of the case. I think it is very much wholesomer for the public to take care of itself in this as in all other matters; and although I am not such a fanatic for the liberty of the subject as to plead that interfering with the way in

which a man may choose to be killed is a violation of that liberty, yet I do think that it is far better to let everybody do as he likes. Whether that be so or not, I am perfectly certain that, as a matter of practice, it is absolutely impossible to prohibit the practice of medicine by people who have no special qualification for it. Consider the terrible consequences of attempting to prohibit practice by a very large class of persons who are certainly not technically qualified — I am far from saying a word as to whether they are otherwise qualified or not. The number of Ladies Bountiful — grandmothers, aunts, and mothers-in-law — whose chief delight lies in the administration of their cherished provision of domestic medicine, is past computation, and one shudders to think of what might happen if their energies were turned from this innocuous, if not beneficent, channel, by the strong arm of the law. But the thing is impracticable.

Another reason for intervention is propounded, I am sorry to say, by some, though not many, members of the medical profession, and is simply an expression of that trades unionism which tends to infest professions no less than trades.

The general practitioner trying to make both ends meet on a poor practice, whose medical training has cost him a good deal of time and money, finds that many potential patients, whose small fees would be welcome as the little that helps, prefer to go and get their shilling's worth of "doctor's stuff" and advice from the chemist and druggist round the corner, who has not paid sixpence for his medical training, because he has never had any.

The general practitioner thinks this is very hard upon him and ought to be stopped. It is perhaps natural that he should think so, though it would be very difficult for him to justify his opinion on any ground of public policy. But the question is really not worth discussion, as it is obvious that it would be utterly impracticable to stop the practice "over the counter" even if it were desirable.

Is a man who has a sudden attack of pain in tooth or stomach not to be permitted to go to the nearest druggist's shop and ask for something that will relieve him? The notion is preposterous. But if this is to be legal, the whole principle of the permissibility of counter practice is granted.

In my judgment the intervention of the State in the affairs of the medical profession can be justified not upon any pretence of protecting the public, and still less upon that of protecting the medical profession, but simply and solely upon the fact that the State employs medical men for certain purposes, and, as employer, has a right to define the conditions on which it will accept service.

It is for the interest of the community that no person shall die without there being some official recognition of the cause of his death. It is a matter of the highest importance to the community that, in civil and criminal cases, the law shall be able to have recourse to persons whose evidence may be taken as that of experts; and it will not be doubted that the State has a right to dictate the conditions under which it will appoint persons to the vast number of naval, military, and civil medical offices held directly or indirectly under the Government. Here, and here only, it appears to me, lies the justification for the intervention of the State in medical affairs. It says, or, in my judgment, should say, to the public, "Practice medicine if you like — go to be practised upon by anybody;" and to the medical practitioner, "Have a qualification, or do not have a qualification, if people don't mind it; but if the State is to receive your certificate of death, if the State is to take your evidence as that of an expert, if the State is to give you any kind of civil, or military, or naval appointment, then we can call upon you to comply with our conditions, and to produce evidence that you are, in our sense of the word, qualified. Without that we will not place you in that position." As a matter of fact, that is the relation of the State to the medical profession in this country. For my part, I think it an extremely healthy relation; and it is one that I should be very sorry to see altered, except in so far that it would certainly be better if greater facilities were given for the swift and sharp punishment of those who profess to have the State qualification when, in point of fact, they do not possess it. They are simply cheats and swindlers, like other people who profess to be what they are not, and should be punished as such.

But supposing we are agreed about the justification of State intervention in medical affairs, new questions arise as to the manner in which that intervention should take place and the extent to which it should go, on which the divergence of opinion is even greater than it is on the general question of intervention.

It is now, I am sorry to say, something over forty years since I began my medical studies; and, at that time the state of affairs was extremely singular. I should think it hardly possible that it could have obtained anywhere but in such a country as England, which cherishes a fine old crusted abuse as much as it does its port wine. At that time there were twenty-one licensing bodies — that is to say, bodies whose certificate was received by the State as evidence that the persons who possessed that certificate were medical experts. How these bodies came to possess these

powers is a very curious chapter in history, in which it would be out of place to enlarge. They were partly universities, partly medical guilds and corporations, partly the Archbishop of Canterbury. Those were the three sources from which the licence to practice came in that day. There was no central authority, there was nothing to prevent any one of those licensing authorities from granting a licence to any one upon any conditions it thought fit. The examination might be a sham, the curriculum might be a sham, the certificate might be bought and sold like anything in a shop; or, on the other hand, the examination might be fairly good and the diploma correspondingly valuable; but there was not the smallest guarantee, except the personal character of the people who composed the administration of each of these licensing bodies, as to what might happen. It was possible for a young man to come to London and to spend two years and six months of the time in his compulsory three years "walking the hospitals" in idleness or worse; he could then, by putting himself in the hands of a judicious "grinder" for the remaining six months, pass triumphantly through the ordeal of one hour's *vivâ voce* examination, which was all that was absolutely necessary, to enable him to be turned loose upon the public, like death on the pale horse, "conquering and to conquer," with the full sanction of the law, as a "qualified practitioner."

It is difficult to imagine, at present, such a state of things, still more difficult to depict the consequences of it, because they would appear like a gross and malignant caricature; but it may be said that there was never a system, or want of system, which was better calculated to ruin the students who came under it, or to degrade the profession as a whole. My memory goes back to a time when models from whom the Bob Sawyer of the *Pickwick Papers* might have been drawn were anything but rare.

Shortly before my student days, however, the dawn of a better state of things in England began to be visible, in consequence of the establishment of the University of London, and the comparatively very high standard which it placed before its medical graduates.

I say comparatively high standard, for the requirements of the University in those days, and even during the twelve years at a later period, when I was one of the examiners of the medical faculty, were such as would not now be thought more than respectable, and indeed were in many respects very imperfect. But, relatively to the means of learning, the standard was high, and none but the more able and ambitious of the students dreamed of passing the University. Nevertheless, the fact that many men of

this stamp did succeed in obtaining their degrees, led others to follow in their steps, and slowly but surely reacted upon the standard of teaching in the better medical schools. Then came the Medical Act of 1858. That Act introduced two immense improvements: one of them was the institution of what is called the Medical Register, upon which the names of all persons recognised by the State as medical practitioners are entered; and the other was the establishment of the Medical Council, which is a kind of Medical Parliament, composed of representatives of the licensing bodies and of leading men in the medical profession nominated by the Crown. The powers given by the Legislature to the Medical Council were found practically to be very limited, but I think that no fair observer of the work will doubt that this much attacked body has excited no small influence in bringing about the great change for the better, which has been effected in the training of men for the medical profession within my recollection.

Another source of improvement must be recognised in the Scottish Universities, and especially in the medical faculty of the University of Edinburgh. The medical education and examinations of this body were for many years the best of their kind in these islands, and I doubt if, at the present moment, the three kingdoms can show a better school of medicine than that of Edinburgh. The vast number of medical students at that University is sufficient evidence of the opinion of those most interested in this subject.

Owing to all these influences, and to the revolution which has taken place in the course of the last twenty years in our conceptions of the proper method of teaching physical science, the training of the medical student in a good school, and the examination test applied by the great majority of the present licensing bodies, reduced now to nineteen, in consequence of the retirement of the Archbishop and the fusion of two of the other licensing bodies, are totally different from what they were even twenty years ago.

I was perfectly astonished, upon one of my sons commencing his medical career the other day, when I contrasted the carefully-watched courses of theoretical and practical instruction, which he is expected to follow with regularity and industry, and the number and nature of the examinations which he will have to pass before he can receive his license, not only with the monstrous laxity of my own student days, but even with the state of things which obtained when my term of office as examiner in the University of London expired some sixteen years ago.

I have no hesitation in expressing the opinion, which is fully borne out by the evidence taken before the late Royal Commission,

that a large proportion of the existing licensing bodies grant their licence on conditions which ensure quite as high a standard as it is practicable or advisable to exact under present circumstances, and that they show every desire to keep pace with the improvements of the times. And I think there can be no doubt that the great majority have so much improved their ways, that their standard is far above that of the ordinary qualification thirty years ago, and I cannot see what excuse there would be for meddling with them, if it were not for two other defects which have to be remedied.

Unfortunately there remain two or three black sheep — licensing bodies which simply trade upon their privilege, and sell the cheapest wares they can for shame's sake supply to the bidder. Another defect in the existing system, even where the examination has been so greatly improved as to be good of its kind, is that there are certain licensing bodies which give a qualification for an acquaintance with either medicine or surgery alone, and which more or less ignore obstetrics. This is a revival of the archaic condition of the profession when surgical operations were mostly left to the barbers and obstetrics to the midwives, and when the physicians thought themselves, and were considered by the world, the "superior persons" of the profession. I remember a story was current in my young days of a great court physician who was travelling with a friend, like himself, bound on a visit to a country house. The friend fell down in an apoplectic fit, and the physician refused to bleed him because it was contrary to professional etiquette for a physician to perform that operation. Whether the friend died or whether he got better because he was not bled I do not remember, but the moral of the story is the same. On the other hand, a famous surgeon was asked whether he meant to bring up his son to his own calling, "No," he said, "he is such a fool, I mean to make a physician of him."

Nowadays, it is happily recognised that medicine is one and indivisible, and that no one can properly practise one branch who is not familiar with at any rate the principles of all. Thus the two great things that are wanted now are, in the first place, some means of enforcing such a degree of uniformity upon all the examining bodies that none should present a disgracefully low minimum or pass examination; and the second point is that some body or other shall have the power of enforcing upon every candidate for the licence to practise the study of the three branches, what is called the tripartite qualification. All the members of the late commission were agreed that these were the main points to be

attended to in any proposals for the further improvement of medical training and qualification.

But such being the ends in view, our notions as to the best way of attaining them were singularly divergent; so that it came about that eleven commissioners made seven reports. There was one main majority report and six minor reports, which differed more or less from it, chiefly as to the best method of attaining these two objects.

The majority report recommended the adoption of what is known as the conjoint scheme. According to this plan the power of granting a licence to practise is to be taken away from all the existing bodies, whether they have done well or ill, and to be placed in the hands of a body of delegates (divisional boards), one for each of the three kingdoms. The licence to practise is to be conferred by passing the delegate examination. The licensee may afterwards, if he pleases, go before any of the existing bodies and indulge in the luxury of another examination and the payment of another fee in order to obtain a title, which does not legally place him in any better position than that which he would occupy without it.

Under these circumstances, of course, the only motive for obtaining the degree of a University or the licence of a medical corporation would be the prestige of these bodies. Hence the "black sheep" would certainly be deserted, while those bodies which have acquired a reputation by doing their duty would suffer less.

But, as the majority report proposes that the existing bodies should be compensated for any loss they might suffer out of the fees of the examiners for the State licence, the curious result would be brought about that the profession of the future would be taxed, for all time, for the purpose of handing over to wholly irresponsible bodies a sum, the amount of which would be large for those who had failed in their duty and small for those who had done it.

The scheme in fact involved a perpetual endowment of the "black sheep," calculated on the maximum of their ill-gained profits. I confess that I found myself unable to consent to a plan which, in addition to the rewarding the evil doers, proposed to take away the privileges of a number of examining bodies which confessedly were doing their duty well, for the sake of getting rid of a few who had failed. It was too much like the Chinaman's device of burning down his house to obtain a poor dish of roast pig — uncertain whether in the end he might not find a mere mass of cinders. What we do know is that the great ma-

jority of the existing licensing bodies have marvellously improved in the course of the last twenty years, and are improving. What we do not know is that the complicated scheme of the divisional boards will ever be got to work at all.

My own belief is that every necessary reform may be effected, without any interference with vested interests, without any unjust interference with the prestige of institutions which have been, and still are, extremely valuable; without any question of compensation arising, and by an extremely simple operation. It is only necessary in fact to add a couple of clauses to the Medical Act to this effect: (1) That from and after such a date no person shall be placed upon the Medical Register unless he possesses the threefold qualification. (2) That from and after this date no examination shall be accepted as satisfactory from any licensing body except such as has been carried on in part by examiners appointed by the licensing body, and in part by coadjutor-examiners of equal authority appointed by the Medical Council or other central authority, and acting under their instructions.

In laying down a rule of this kind the State confiscates nothing, and meddles with nobody, but simply acts within its undoubted right of laying down the conditions under which it will confer certain privileges upon medical practitioners. No one can say that the State has not the right to do this; no one can say that the State interferes with any private enterprise or corporate interest unjustly, in laying down its own conditions for its own service. The plan would have the further advantage that all those corporate bodies which have obtained (as many of them have) a great and just prestige by the admirable way in which they have done their work, would reap their just reward in the thronging of students, thenceforward as formerly, to obtain their qualifications; while those who have neglected their duties, who have in some one or two cases, I am sorry to say, absolutely disgraced themselves, would sink into oblivion, and come to a happy and natural euthanasia, in which their misdeeds and themselves would be entirely forgotten.

Two of my colleagues, Professor Turner and Mr. Bryce, M. P., whose practical familiarity with examinations gave their opinions a high value, expressed their substantial approval of this scheme, and I am unable to see the weight of the objections urged against it. It is urged that the difficulty and expense of adequately inspecting so many examinations and of guaranteeing their efficiency would be great, and the difficulty in the way of a fair adjustment of the representation of existing interests and of the

representation of new interests upon the general Medical Council would be almost insuperable.

The latter objection is unintelligible to me. I am not aware that any attempt at such adjustment has been fairly discussed, and until that has been done it may be well not to talk about insuperable difficulties. As to the notion that there is any difficulty in getting the coadjutor-examiners, or that the expense will be overwhelming, we have the experience of Scotland, in which every University does, at the present time, appoint its coadjutor-examiners, who do their work just in the way proposed.

Whether in the way I have proposed, or by the Conjoint Scheme, however, this is perfectly certain: the two things I refer to have to be done: you must have the threefold qualification; you must have the limitation of the minimum qualification also; and any scheme for the improvement of the relations of the State to medicine which does not profess to do these two things thoroughly and well, has no chance of finality.

But when these reforms are witnessed, when there is a Medical Council armed with a more real authority than it at present possesses; when a licence to practise cannot be obtained without the threefold qualification; and when an even minimum of qualification is exacted for every licence, is there anything else that remains that any one seriously interested in the welfare of the medical profession, as I may most conscientiously declare myself to be, would like to see done? I think there are three things.

In the first place, even now, when a four years' curriculum is required, the time allotted for medical education is too brief. A young man of eighteen beginning to study medicine is probably absolutely ignorant of the existence of such a thing as anatomy, or physiology, or indeed of any branch of physical science. He comes into an entirely new world; he addresses himself to a kind of work of which he has not the smallest experience. Up to that time his work has been with books; he rushes suddenly into work with things, which is as different from work with books as anything can well be. I am quite sure that a very considerable number of young men spend a very large portion of their first session in simply learning how to learn subjects which are entirely new to them. And yet recollect that in this period of four years they have to acquire a knowledge of all the branches of a great and responsible practical calling of medicine, surgery, obstetrics, general pathology, medical jurisprudence, and so forth. Anybody who knows what these things are, and who knows what is the kind of work which is necessary to give a man the confidence which will enable him to stand at the bedside and say to the satisfaction of

his own conscience what shall be done, and what shall not be done, must be aware that if a man has only four years to do all that in he will not have much time to spare. But that is not all. As I have said, the young man comes up, probably ignorant of the existence of science; he has never heard a word of chemistry, he has never heard a word of physics, he has not the smallest conception of the outlines of biological science; and all these things have to be learned as well and crammed into the time which in itself is barely sufficient to acquire a fair amount of that knowledge which is requisite for the satisfactory discharge of his professional duties.

Therefore it is quite clear to me that, somehow or other, the curriculum must be lightened. It is not that any of the subjects which I have mentioned need not to be studied, and may be eliminated. The only alternative therefore is to lengthen the time given to study. Everybody will agree with me that the practical necessities of life in this country are such that, for the average medical practitioner at any rate, it is hopeless to think of extending the period of professional study beyond the age of twenty-two. So that as the period of study cannot be extended forwards, the only thing to be done is to extend it backwards.

The question is how this can be done. My own belief is that if the Medical Council, instead of insisting upon that examination in general education which I am sorry to say I believe to be entirely futile, were to insist upon a knowledge of elementary physics, and chemistry, and biology, they would be taking one of the greatest steps which at present can be made for the improvement of medical education. And the improvement would be this. The great majority of the young men who are going into the profession have practically completed their general education — or they might very well have done so — by the age of sixteen or seventeen. If the interval between this age and that at which they commence their purely medical studies were employed in obtaining a practical acquaintance with elementary physics, chemistry, and biology, in my judgment it would be as good as two years added to the course of medical study. And for two reasons: in the first place, because the subject-matter of that which they would learn is germane to their future studies, and is so much gained; in the second place, because you might clear out of the course of their professional study a great deal which at present occupies time and attention; and last, but not least — probably most — they would then come to their medical studies prepared for that learning from Nature which is what they have to do in the course of becoming skilful medical men, and for which

at present they are not in the slightest degree prepared by their previous education.

The second wish I have to express concerns London especially, and I may speak of it briefly as a more economical use of the teaching power in the medical schools. At this present time every great hospital in London — and there are ten or eleven of them — has its complete medical school, in which not only are the branches of practical medicine taught, but also those studies in general science, such as chemistry, elementary physics, general anatomy, and a variety of other topics which are what used to be called (and the term was an extremely useful one) the institutes of medicine. That was all very well half a century ago; it is all very ill now, simply because those general branches of science, such as anatomy, physiology, chemistry, physiological chemistry, physiological physics, and so forth, have now become so large, and the mode of teaching them is so completely altered, that it is absolutely impossible for any man to be a thoroughly competent teacher of them, or for any student to be effectually taught without the devotion of the whole time of the person who is engaged in teaching. I undertake to say that it is hopelessly impossible for any man at the present time to keep abreast with the progress of physiology unless he gives his whole mind to it; and the bigger the mind is, the more scope he will find for its employment. Again, teaching has become, and must become still more, practical, and that also involves a large expenditure of time. But if a man is to give his whole time to any business he must live by it, and the resources of the schools do not permit them to maintain ten or eleven physiological specialists.

If the students in their first one or two years were taught the institutes of medicine, in two or three central institutions, it would be perfectly easy to have those subjects taught thoroughly and effectually by persons who gave their whole mind and attention to the subject; while at the same time the medical schools at the hospitals would remain what they ought to be — great institutions in which the largest possible opportunities are laid open for acquiring practical acquaintance with the phenomena of disease. So that the preliminary or earlier half of medical education would take place in the central institutions, and the final half would be devoted altogether to practical studies in the hospitals.

I happen to know that this conception has been entertained, not only by myself, but by a great many of those persons who are most interested in the improvement of medical study for a considerable number of years. I do not know whether anything

will come of it this half-century or not; but the thing has to be done. It is not a speculative notion; it lies patent to everybody who is accustomed to teaching, and knows what the necessities of teaching are; and I should very much like to see the first step taken — people making up their minds that it has to be done somehow or other.

The last point to which I may advert is one which concerns the action of the profession itself more than anything else. We have arrangements for teaching, we have arrangements for the testing of qualifications, we have marvellous aids and appliances for the treatment of disease in all sorts of ways; but I do not find in London at the present time, in this little place of four or five million inhabitants which supports so many things, any organisation or any arrangement for advancing the science of medicine, considered as a pure science. I am quite aware that there are medical societies of various kinds; I am not ignorant of the lectureships at the College of Physicians and the College of Surgeons; there is the Brown Institute; and there is the Society for the Advancement of Medicine by Research, but there is no means, so far as I know, by which any person who has the inborn gifts of the investigator and discoverer of new truth, and who desires to apply that to the improvement of medical science, can carry out his intention. In Paris there is the University of Paris, which gives degrees; but there are also the Sorbonne and the Collége de France, places in which professoriates are established for the express purpose of enabling men who have the power of investigation, the power of advancing knowledge and thereby reacting on practice, to do that which it is their special mission to do. I do not know of anything of the kind in London; and if it should so happen that a Claude Bernard or a Ludwig should turn up in London, I really have not the slightest notion of what we could do with him. We could not turn him to account, and I think we should have to export him to Germany or France. I doubt whether that is a good or a wise condition of things. I do not think it is a condition of things which can exist for any great length of time, now that people are every day becoming more and more awake to the importance of scientific investigation and to the astounding and unexpected manner in which it everywhere reacts upon practical pursuits. I should look upon the establishment of some institution of that kind as a recognition on the part of the medical profession in general, that if their great and beneficent work is to be carried on, they must, like other people who have great and beneficent work to do, contribute to the advancement of knowledge in the only way in which experience shows that it can be advanced.

XIV.

THE CONNECTION OF THE BIOLOGICAL SCIENCES WITH MEDICINE.*

THE great body of theoretical and practical knowledge which has been accumulated by the labours of some eighty generations, since the dawn of scientific thought in Europe, has no collective English name to which an objection may not be raised; and I use the term "medicine" as that which is least likely to be misunderstood; though, as every one knows, the name is commonly applied, in a narrower sense, to one of the chief divisions of the totality of medical science.

Taken in this broad sense, "medicine" not merely denotes a kind of knowledge, but it comprehends the various applications of that knowledge to the alleviation of the sufferings, the repair of the injuries, and the conservation of the health, of living beings. In fact, the practical aspect of medicine so far dominates over every other, that the "Healing Art" is one of its most widely-received synonyms. It is so difficult to think of medicine otherwise than as something which is necessarily connected with curative treatment, that we are apt to forget that there must be, and is, such a thing as a pure science of medicine — a "pathology" which has no more necessary subservience to practical ends than has zoology or botany.

The logical connection between this purely scientific doctrine of disease, or pathology, and ordinary biology, is easily traced. Living matter is characterised by its innate tendency to exhibit a definite series of the morphological and physiological phenomena which constitute organisation and life. Given a certain range of conditions, and these phenomena remain the same, within narrow limits, for each kind of living thing. They furnish the normal and typical character of the species, and, as such, they are the subject-matter of ordinary biology.

Outside the range of these conditions, the normal course of the cycle of vital phenomena is disturbed; abnormal structure

* An address to the International Medical Congress.

makes its appearance, or the proper character and mutual adjustment of the functions cease to be preserved. The extent and the importance of these deviations from the typical life may vary indefinitely. They may have no noticeable influence on the general well-being of the economy, or they may favour it. On the other hand, they may be of such a nature as to impede the activities of the organism, or even to involve its destruction.

In the first case, these perturbations are ranged under the wide and somewhat vague category of "variations"; in the second, they are called lesions, states of poisoning, or diseases; and, as morbid states, they lie within the province of pathology. No sharp line of demarcation can be drawn between the two classes of phenomena. No one can say where anatomical variations end and tumours begin, or where modification of function, which may at first promote health, passes into disease. All that can be said is, that whatever change of structure or function is hurtful belongs to pathology. Hence it is obvious that pathology is a branch of biology; it is the morphology, the physiology, the distribution, the ætiology of abnormal life.

However obvious this conclusion may be now, it was nowise apparent in the infancy of medicine. For it is a peculiarity of the physical sciences that they are independent in proportion as they are imperfect; and it is only as they advance that the bonds which really unite them all become apparent. Astronomy had no manifest connection with terrestrial physics before the publication of the "Principia"; that of chemistry with physics is of still more modern revelation; that of physics and chemistry with physiology, has been stoutly denied within the recollection of most of us, and perhaps still may be.

Or, to take a case which affords a closer parallel with that of medicine. Agriculture has been cultivated from the earliest times, and, from a remote antiquity, men have attained considerable practical skill in the cultivation of the useful plants, and have empirically established many scientific truths concerning the conditions under which they flourish. But, it is within the memory of many of us, that chemistry on the one hand, and vegetable physiology on the other, attained a stage of development such that they were able to furnish a sound basis for scientific agriculture. Similarly, medicine took its rise in the practical needs of mankind. At first, studied without reference to any other branch of knowledge, it long maintained, indeed still to some extent maintains, that independence. Historically, its connection with the biological sciences has been slowly established, and the full extent and intimacy of that connection are

only now beginning to be apparent. I trust I have not been mistaken in supposing that an attempt to give a brief sketch of the steps by which a philosophical necessity has become an historical reality, may not be devoid of interest, possibly of instruction, to the members of this great Congress, profoundly interested as all are in the scientific development of medicine.

The history of medicine is more complete and fuller than that of any other science, except, perhaps, astronomy; and, if we follow back the long record as far as clear evidence lights us, we find ourselves taken to the early stages of the civilisation of Greece. The oldest hospitals were the temples of Æsculapius; to these Asclepeia, always erected on healthy sites, hard by fresh springs and surrounded by shady groves, the sick and the maimed resorted to seek the aid of the god of health. Votive tablets or inscriptions recorded the symptoms, no less than the gratitude, of those who were healed; and, from these primitive clinical records, the half-priestly, half-philosophic caste of the Asclepiads compiled the data upon which the earliest generalisations of medicine, as an inductive science, were based.

In this state, pathology, like all the inductive sciences at their origin, was merely natural history; it registered the phenomena of disease, classified them, and ventured upon a prognosis, wherever the observation of constant co-existences and sequences suggested a rational expectation of the like recurrence under similar circumstances.

Further than this it hardly went. In fact, in the then state of knowledge, and in the condition of philosophical speculation at that time, neither the causes of the morbid state, nor the *rationale* of treatment, were likely to be sought for as we seek for them now. The anger of a god was a sufficient reason for the existence of a malady, and a dream ample warranty for therapeutic measures; that a physical phenomenon must needs have a physical cause was not the implied or expressed axiom that it is to us moderns.

The great man whose name is inseparably connected with the foundation of medicine, Hippocrates, certainly knew very little, indeed practically nothing, of anatomy or physiology; and he would probably have been perplexed even to imagine the possibility of a connection between the zoological studies of his contemporary Democritus and medicine. Nevertheless, in so far as he, and those who worked before and after him, in the same spirit, ascertained, as matters of experience, that a wound, or a luxation, or a fever, presented such and such symptoms, and that the return of the patient to health was facilitated by such and such

measures, they established laws of nature, and began the construction of the science of pathology. All true science begins with empiricism — though all true science is such exactly, in so far as it strives to pass out of the empirical stage into that of the deduction of empirical from more general truths. Thus, it is not wonderful, that the early physicians had little or nothing to do with the development of biological science; and, on the other hand, that the early biologists did not much concern themselves with medicine. There is nothing to show that the Asclepiads took any prominent share in the work of founding anatomy, physiology, zoology, and botany. Rather do these seem to have sprung from the early philosophers, who were essentially natural philosophers, animated by the characteristically Greek thirst for knowledge as such. Pythagoras, Alcmeon, Democritus, Diogenes of Apollonia, are all credited with anatomical and physiological investigations; and, though Aristotle is said to have belonged to an Asclepiad family, and not improbably owed his taste for anatomical and zoological inquiries to the teachings of his father, the physician Nicomachus, the "Historia Animalium," and the treatise "De Partibus Animalium," are as free from any allusion to medicine as if they had issued from a modern biological laboratory.

It may be added, that it is not easy to see in what way it could have benefited a physician of Alexander's time to know all that Aristotle knew on these subjects. His human anatomy was too rough to avail much in diagnosis; his physiology was too erroneous to supply data for pathological reasoning. But when the Alexandrian school, with Erasistratus and Herophilus at their head, turned to account the opportunities of studying human structure, afforded to them by the Ptolemies, the value of the large amount of accurate knowledge thus obtained to the surgeon for his operations, and to the physician for his diagnosis of internal disorders, became obvious, and a connection was established between anatomy and medicine, which has ever become closer and closer. Since the revival of learning, surgery, medical diagnosis, and anatomy have gone hand in hand. Morgagni called his great work, "De sedibus et causis morborum per anatomen indagatis," and not only showed the way to search out the localities and the causes of disease by anatomy, but himself travelled wonderfully far upon the road. Bichat, discriminating the grosser constituents of the organs and parts of the body, one from another, pointed out the direction which modern research must take; until, at length, histology, a science of yesterday, as it seems to many of us, has carried the work of Morgagni as

far as the microscope can take us, and has extended the realm of pathological anatomy to the limits of the invisible world.

Thanks to the intimate alliance of morphology with medicine, the natural history of disease has, at the present day, attained a high degree of perfection. Accurate regional anatomy has rendered practicable the exploration of the most hidden parts of the organism, and the determination, during life, of morbid changes in them; anatomical and histological post-mortem investigations have supplied physicians with a clear basis upon which to rest the classification of diseases, and with unerring tests of the accuracy or inaccuracy of their diagnoses.

If men could be satisfied with pure knowledge, the extreme precision with which, in these days, a sufferer may be told what is happening, and what is likely to happen, even in the most recondite parts of his bodily frame, should be as satisfactory to the patient as it is to the scientific pathologist who gives him the information. But I am afraid it is not; and even the practising physician, while nowise under-estimating the regulative value of accurate diagnosis, must often lament that so much of his knowledge rather prevents him from doing wrong than helps him to do right.

A scorner of physic once said that nature and disease may be compared to two men fighting, the doctor to a blind man with a club, who strikes into the *mêlée,* sometimes hitting the disease, and sometimes hitting nature. The matter is not mended if you suppose the blind man's hearing to be so acute that he can register every stage of the struggle, and pretty clearly predict how it will end. He had better not meddle at all, until his eyes are opened, until he can see the exact position of the antagonists, and make sure of the effect of his blows. But that which it behooves the physician to see, not, indeed, with his bodily eye, but with clear, intellectual vision, is a process, and the chain of causation involved in that process. Disease, as we have seen, is a perturbation of the normal activities of a living body, and it is, and must remain, unintelligible, so long as we are ignorant of the nature of these normal activities. In other words, there could be no real science of pathology until the science of physiology had reached a degree of perfection unattained, and indeed unattainable, until quite recent times.

So far as medicine is concerned, I am not sure that physiology, such as it was down to the time of Harvey, might as well not have existed. Nay, it is perhaps no exaggeration to say that, within the memory of living men, justly renowned practitioners of medicine and surgery knew less physiology than is now to be

learned from the most elementary text-book; and, beyond a few broad facts, regarded what they did know as of extremely little practical importance. Nor am I disposed to blame them for this conclusion; physiology must be useless, or worse than useless, to pathology, so long as its fundamental conceptions are erroneous.

Harvey is often said to be the founder of modern physiology; and there can be no question that the elucidations of the function of the heart, of the nature of the pulse, and of the course of the blood, put forth in the ever-memorable little essay, "De motu cordis," directly worked a revolution in men's views of the nature and of the concatenation of some of the most important physiological processes among the higher animals; while, indirectly, their influence was perhaps even more remarkable.

But, though Harvey made this signal and perennially important contribution to the physiology of the moderns, his general conception of vital processes was essentially identical with that of the ancients; and, in the "Exercitationes de generatione," and notably in the singular chapter "De calido innato," he shows himself a true son of Galen and of Aristotle.

For Harvey, the blood possesses powers superior to those of the elements; it is the seat of a soul which is not only vegetative, but also sensitive and motor. The blood maintains and fashions all parts of the body, "idque summâ cum providentiâ et intellectu in finem certum agens, quasi ratiocinio quodam uteretur."

Here is the doctrine of the "pneuma," the product of the philosophical mould into which the animism of primitive men ran in Greece, in full force. Nor did its strength abate for long after Harvey's time. The same ingrained tendency of the human mind to suppose that a process is explained when it is ascribed to a power of which nothing is known except that it is the hypothetical agent of the process, gave rise, in the next century, to the animism of Stahl; and, later, to the doctrine of a vital principle, that "asylum ignorantiæ" of physiologists, which has so easily accounted for everything and explained nothing, down to our own times.

Now the essence of modern, as contrasted with ancient, physiological science appears to me to lie in its antagonism to animistic hypotheses and animistic phraseology. It offers physical explanations of vital phenomena, or frankly confesses that it has none to offer. And, so far as I know, the first person who gave expression to this modern view of physiology, who was bold enough to enunciate the proposition that vital phenomena, like all the

other phenomena of the physical world, are, in ultimate analysis, resolvable into matter and motion, was Rene Descartes.

The fifty-four years of life of this most original and powerful thinker are widely overlapped, on both sides, by the eighty of Harvey, who survived his younger contemporary by seven years, and takes pleasure in acknowledging the French philosopher's appreciation of his great discovery.

In fact, Descartes accepted the doctrine of the circulation as propounded by "Harvæus médecin d'Angleterre," and gave a full account of it in his first work, the famous "Discours de la Méthode," which was published in 1637, only nine years after the exercitation "De motu cordis"; and, though differing from Harvey on some important points (in which it may be noted, in passing, Descartes was wrong and Harvey right), he always speaks of him with great respect. And so important does the subject seem to Descartes, that he returns to it in the "Traité des Passions," and in the "Traité de l'Homme."

It is easy to see that Harvey's work must have had a peculiar significance for the subtle thinker, to whom we owe both the spiritualistic and the materialistic philosophies of modern times. It was in the very year of its publication, 1628, that Descartes withdrew into that life of solitary investigation and meditation of which his philosophy was the fruit. And, as the course of his speculations led him to establish an absolute distinction of nature between the material and the mental worlds, he was logically compelled to seek for the explanation of the phenomena of the material world within itself; and having allotted the realm of thought to the soul, to see nothing but extension and motion in the rest of nature. Descartes uses "thought" as the equivalent of our modern term "consciousness." Thought is the function of the soul, and its only function. Our natural heat and all the movements of the body, says he, do not depend on the soul. Death does not take place from any fault of the soul, but only because some of the principal parts of the body become corrupted. The body of a living man differs from that of a dead man in the same way as a watch or other automaton (that is to say, a machine which moves of itself) when it is wound up and has, in itself, the physical principle of the movements which the mechanism is adapted to perform, differs from the same watch, or other machine, when it is broken, and the physical principle of its movement no longer exists. All the actions which are common to us and the lower animals depend only on the conformation of our organs, and the course which the animal spirits take in the brain, the nerves, and the muscles; in the same way as the

movement of a watch is produced by nothing but the force of its spring and the figure of its wheels and other parts.

Descartes' "Treatise on Man" is a sketch of human physiology, in which a bold attempt is made to explain all the phenomena of life, except those of consciousness, by physical reasonings. To a mind turned in this direction, Harvey's exposition of the heart and vessels as a hydraulic mechanism must have been supremely welcome.

Descartes was not a mere philosophical theorist, but a hard-working dissector and experimenter, and he held the strongest opinion respecting the practical value of the new conception which he was introducing. He speaks of the importance of preserving health, and of the dependence of the mind on the body being so close that, perhaps, the only way of making men wiser and better than they are, is to be sought in medical science. "It is true," says he, "that as medicine is now practised it contains little that is very useful; but without any desire to depreciate, I am sure that there is no one, even among professional men, who will not declare that all we know is very little as compared with that which remains to be known; and that we might escape an infinity of diseases of the mind, no less than of the body, and even perhaps from the weakness of old age, if we had sufficient knowledge of their causes, and of all the remedies with which nature has provided us."* So strongly impressed was Descartes with this, that he resolved to spend the rest of his life in trying to acquire such a knowledge of nature as would lead to the construction of a better medical doctrine.† The anti-Cartesians found material for cheap ridicule in these aspirations of the philosopher; and it is almost needless to say that, in the thirteen years which elapsed between the publication of the "Discours" and the death of Descartes, he did not contribute much to their realisation. But, for the next century, all progress in physiology took place along the lines which Descartes laid down.

The greatest physiological and pathological work of the seventeenth century, Borelli's treatise "De Motu Animalium," is, to all intents and purposes, a development of Descartes' fundamental conception; and the same may be said of the physiology and pathology of Boerhaave, whose authority dominated in the medical world of the first half of the eighteenth century.

With the origin of modern chemistry, and of electrical science, in the latter half of the eighteenth century, aids in the analysis of the phenomena of life, of which Descartes could not have

* *Discours de la Méthode*, 6e partie, Ed. Cousin, p. 193.
† *Ibid.* pp. 193 and 211.

dreamed, were offered to the physiologist. And the greater part of the gigantic progress which has been made in the present century is a justification of the prevision of Descartes. For it consists, essentially, in a more and more complete resolution of the grosser organs of the living body into physico-chemical mechanisms.

"I shall try to explain our whole bodily machinery in such a way, that it will be no more necessary for us to suppose that the soul produces such movements as are not voluntary, than it is to think that there is in a clock a soul which causes it to show the hours." * These words of Descartes might be appropriately taken as a motto by the author of any modern treatise on physiology.

But though, as I think, there is no doubt that Descartes was the first to propound the fundamental conception of the living body as a physical mechanism, which is the distinctive feature of modern, as contrasted with ancient physiology, he was misled by the natural temptation to carry out, in all its details, a parallel between the machines with which he was familiar, such as clocks and pieces of hydraulic apparatus, and the living machine. In all such machines there is a central source of power, and the parts of the machine are merely passive distributors of that power. The Cartesian school conceived of the living body as a machine of this kind; and herein they might have learned from Galen, who, whatever ill use he may have made of the doctrine of "natural faculties," nevertheless had the great merit of perceiving that local forces play a great part in physiology.

The same truth was recognised by Glisson, but it was first prominently brought forward in the Hallerian doctrine of the "vis insita" of muscles. If muscle can contract without nerve, there is an end of the Cartesian mechanical explanation of its contraction by the influx of animal spirits.

The discoveries of Trembley tended in the same direction. In the freshwater *Hydra,* no trace was to be found of that complicated machinery upon which the performance of the functions in the higher animals were supposed to depend. And yet the hydra moved, fed, grew, multiplied, and its fragments exhibited all the powers of the whole. And, finally, the work of Caspar F. Wolff,† by demonstrating the fact that the growth and development of both plants and animals take place antecedently to the existence of their grosser organs, and are, in fact, the causes and not the consequences of organisation (as then understood), sapped

* *De la Formation du Fœtus.*
† *Theoria Generationis,* 1759.

the foundations of the Cartesian physiology as a complete expression of vital phenomena.

For Wolff, the physical basis of life is a fluid, possessed of a "vis essentialis" and a "solidescibilitas," in virtue of which it gives rise to organisation; and, as he points out, this conclusion strikes at the root of the whole iatro-mechanical system.

In this country, the great authority of John Hunter exerted a similar influence; though it must be admitted that the too sibylline utterances which are the outcome of Hunter's struggles to define his conceptions are often susceptible of more than one interpretation. Nevertheless, on some points Hunter is clear enough. For example, he is of opinion that "Spirit is only a property of matter" ("Introduction to Natural History," p. 6), he is prepared to renounce animism, (*l. c.* p. 8), and his conception of life is so completely physical that he thinks of it as something which can exist in a state of combination in the food. "The aliment we take in has in it, in a fixed state, the real life; and this does not become active until it has got into the lungs; for there it is freed from its prison" ("Observations on Physiology," p. 113). He also thinks that "It is more in accord with the general principles of the animal machine to suppose that none of its effects are produced from any mechanical principle whatever; and that every effect is produced from an action in the part; which action is produced by a stimulus upon the part which acts, or upon some other part with which this part sympathises so as to take up the whole action" (*l. c.* p. 152).

And Hunter is as clear as Wolff, with whose work he was probably unacquainted, that "whatever life is, it most certainly does not depend upon structure or organisation" (*l. c.* p. 114).

Of course it is impossible that Hunter could have intended to deny the existence of purely mechanical operations in the animal body. But while, with Borelli and Boerhaave, he looked upon absorption, nutrition, and secretion as operations effected by means of the small vessels, he differed from the mechanical physiologists, who regarded these operations as the result of the mechanical properties of the small vessels, such as the size, form, and disposition of their canals and apertures. Hunter, on the contrary, considers them to be the effect of properties of these vessels which are not mechanical but vital. "The vessels," says he, "have more of the polypus in them than any other part of the body," and he talks of the "living and sensitive principles of the arteries," and even of the "dispositions or feelings of the arteries." "When the blood is good and genuine the sensations of the arteries, or the dispositions for sensation, are agreeable.

. . . It is then they dispose of the blood to the best advantage, increasing the growth of the whole, supplying any losses, keeping up a due succession, etc." (*l. c.* p. 133).

If we follow Hunter's conceptions to their logical issue, the life of one of the higher animals is essentially the sum of the lives of all the vessels, each of which is a sort of physiological unit, answering to a polype; and, as health is the result of the normal "action of the vessels," so is disease an effect of their abnormal action. Hunter thus stands in thought, as in time, midway between Borelli on the one hand, and Bichat on the other.

The acute founder of general anatomy, in fact, outdoes Hunter in his desire to exclude physical reasonings from the realm of life. Except in the interpretation of the action of the sense organs, he will not allow physics to have anything to do with physiology.

"To apply the physical sciences to physiology is to explain the phenomena of living bodies by the laws of inert bodies. Now this is a false principle, hence all its consequences are marked with the same stamp. Let us leave to chemistry its affinity; to physics, its elasticity and its gravity. Let us invoke for physiology only sensibility and contractility." *

Of all the unfortunate dicta of men of eminent ability this seems one of the most unhappy, when we think of what the application of the methods and the data of physics and chemistry has done towards bringing physiology into its present state. It is not too much to say that one-half of a modern text-book of physiology consists of applied physics and chemistry; and that it is exactly in the exploration of the phenomena of sensibility and contractility that physics and chemistry have exerted the most potent influence.

Nevertheless, Bichat rendered a solid service to physiological progress by insisting upon the fact that what we call life, in one of the higher animals, is not an indivisible unitary archæus dominating, from its central seat, the parts of the organism, but a compound result of the synthesis of the separate lives of those parts.

"All animals," says he, "are assemblages of different organs, each of which performs its function and concurs, after its fashion, in the preservation of the whole. They are so many special machines in the general machine which constitutes the individual. But each of these special machines is itself compounded of many tissues of very different natures, which in truth constitute the elements of those organs" (*l. c.* lxxix.). "The conception of a

* *Anatomie générale.*

proper vitality is applicable only to these simple tissues, and not to the organs themselves" (*l. c.* lxxxiv.).

And Bichat proceeds to make the obvious application of this doctrine of synthetic life, if I may so call it, to pathology. Since diseases are only alterations of vital properties, and the properties of each tissue are distinct from those of the rest, it is evident that the diseases of each tissue must be different from those of the rest. Therefore, in any organ composed of different tissues, one may be diseased and the other remain healthy; and this is what happens in most cases (*l. c.* lxxxv.).

In a spirit of true prophecy, Bichat says, "We have arrived at an epoch in which pathological anatomy should start afresh." For, as the analysis of the organs had led him to the tissues as the physiological units of the organism; so, in a succeeding generation, the analysis of the tissues led to the cell as the physiological element of the tissues. The contemporaneous study of development brought out the same result; and the zoologists and botanists, exploring the simplest and the lowest forms of animated beings, confirmed the great induction of the cell theory. Thus the apparently opposed views, which have been battling with one another ever since the middle of the last century, have proved to be each half the truth.

The proposition of Descartes that the body of a living man is a machine, the actions of which are explicable by the known laws of matter and motion, is unquestionably largely true. But it is also true, that the living body is a synthesis of innumerable physiological elements, each of which may nearly be described, in Wolff's words, as a fluid possessed of a "vis essentialis" and a "solidescibilitas"; or, in modern phrase, as protoplasm susceptible of structural metamorphosis and functional metabolism: and that the only machinery, in the precise sense in which the Cartesian school understood mechanism, is that which co-ordinates and regulates these physiological units into an organic whole.

In fact, the body is a machine of the nature of an army, not of that of a watch or of a hydraulic apparatus. Of this army each cell is a soldier, an organ a brigade, the central nervous system headquarters and field telegraph, the alimentary and circulatory system the commissariat. Losses are made good by recruits born in camp, and the life of the individual is a campaign, conducted successfully for a number of years, but with certain defeat in the long run.

The efficacy of an army, at any given moment, depends on the health of the individual soldier, and on the perfection of the machinery by which he is led and brought into action at the

proper time; and, therefore, if the analogy holds good, there can be only two kinds of diseases, the one dependent on abnormal states of the physiological units, the other on perturbations of their co-ordinating and alimentative machinery.

Hence, the establishment of the cell theory, in normal biology, was swiftly followed by a "cellular pathology," as its logical counterpart. I need not remind you how great an instrument of investigation this doctrine has proved in the hands of the man of genius to whom its development is due, and who would probably be the last to forget that abnormal conditions of the co-ordinative and distributive machinery of the body are no less important factors of disease.

Henceforward, as it appears to me, the connection of medicine with the biological sciences is clearly indicated. Pure pathology is that branch of biology which defines the particular perturbation of cell-life, or of the co-ordinating machinery, or of both, on which the phenomena of disease depend.

Those who are conversant with the present state of biology will hardly hesitate to admit that the conception of the life of one of the higher animals as the summation of the lives of a cell aggregate, brought into harmonious action by a co-ordinative machinery formed by some of these cells, constitutes a permanent acquisition of physiological science. But the last form of the battle between the animistic and the physical views of life is seen in the contention whether the physical analysis of vital phenomena can be carried beyond this point or not.

There are some to whom living protoplasm is a substance, even such as Harvey conceived the blood to be, "summâ cum providentiâ et intellectu in finem certum agens, quasi ratiocinio quodam;" and who look with as little favour as Bichat did, upon any attempt to apply the principles and the methods of physics and chemistry to the investigation of the vital processes of growth, metabolism, and contractility. They stand upon the ancient ways; only, in accordance with that progress towards democracy, which a great political writer has declared to be the fatal characteristic of modern times, they substitute a republic formed by a few billion of "animulæ" for the monarchy of the all-pervading "anima."

Others, on the contrary, supported by a robust faith in the universal applicability of the principles laid down by Descartes, and seeing that the actions called "vital" are, so far as we have any means of knowing, nothing but changes of place of particles of matter, look to molecular physics to achieve the analysis of the living protoplasm itself into a molecular mechanism. If there

is any truth in the received doctrines of physics, that contrast between living and inert matter, on which Bichat lays so much stress, does not exist. In nature, nothing is at rest, nothing is amorphous; the simplest particle of that which men in their blindness are pleased to call "brute matter" is a vast aggregate of molecular mechanisms performing complicated movements of immense rapidity, and sensitively adjusting themselves to every change in the surrounding world. Living matter differs from other matter in degree and not in kind; the microcosm repeats the macrocosm; and one chain of causation connects the nebulous original of suns and planetary systems with the protoplasmic foundation of life and organisation.

From this point of view, pathology is the analogue of the theory of perturbations in astronomy; and therapeutics resolves itself into the discovery of the means by which a system of forces competent to eliminate any given perturbation may be introduced into the economy. And, as pathology bases itself upon normal physiology, so therapeutics rests upon pharmacology; which is, strictly speaking, a part of the great biological topic of the influence of conditions on the living organism, and has no scientific foundation apart from physiology.

It appears to me that there is no more hopeful indication of the progress of medicine towards the ideal of Descartes than is to be derived from a comparison of the state of pharmacology, at the present day, with that which existed forty years ago. If we consider the knowledge positively acquired, in this short time, of the *modus operandi* of urari, of atropia, of physostigmin, of veratria, of casca, of strychnia, of bromide of potassium, of phosphorus, there can surely be no ground for doubting that, sooner or later, the pharmacologist will supply the physician with the means of affecting, in any desired sense, the functions of any physiological element of the body. It will, in short, become possible to introduce into the economy a molecular mechanism which, like a very cunningly-contrived torpedo, shall find its way to some particular group of living elements, and cause an explosion among them, leaving the rest untouched.

The search for the explanation of diseased states in modified cell-life; the discovery of the important part played by parasitic organisms in the ætiology of disease; the elucidation of the action of medicaments by the methods and the data of experimental physiology; appear to me to be the greatest steps which have ever been made towards the establishment of medicine on a scientific basis. I need hardly say they could not have been made except for the advance of normal biology.

There can be no question, then, as to the nature or the value of the connection between medicine and the biological sciences. There can be no doubt that the future of pathology and of therapeutics, and, therefore, that of practical medicine, depends upon the extent to which those who occupy themselves with these subjects are trained in the methods and impregnated with the fundamental truths of biology.

And, in conclusion, I venture to suggest that the collective sagacity of this Congress could occupy itself with no more important question than with this: How is medical education to be arranged, so that, without entangling the student in those details of the systematist which are valueless to him, he may be enabled to obtain a firm grasp of the great truths respecting animal and vegetable life, without which, notwithstanding all the progress of scientific medicine, he will still find himself an empiric?

XV.

THE SCHOOL BOARDS: WHAT THEY CAN DO, AND WHAT THEY MAY DO.

AN electioneering manifesto would be out of place in the pages of this Review; but any suspicion that may arise in the mind of the reader that the following pages partae of that nature, will be dispelled, if he reflect that they cannot be published* until after the day on which the ratepayers of the metropolis will have decided which candidates for seats upon the Metropolitan School Board they will take, and which they will leave.

As one of those candidates, I may be permitted to say, that I feel much in the frame of mind of the Irish bricklayer's laborer, who bet another that he could not carry him to the top of the ladder in his hod. The challenged hodman won his wager, but as the stakes were handed over, the challenger wistfully remarked, "I'd great hopes of falling at the third round from the top." And, in view of the work and the worry which awaits the members of the School Boards, I must confess to an occasional ungrateful hope that the friends who are toiling upwards with me in their hod, may, when they reach "the third round from the top," let me fall back into peace and quietness.

But whether fortune befriend me in this rough method, or not, I should like to submit to those of whom I am potential, but of whom I may not be an actual, colleague, and to others who may be interested in this most important problem — how to get the Education Act to work efficiently — some considerations as to what are the duties of the members of the School Boards, and what are the limits of their power.

I suppose no one will be disposed to dispute the proposition, that the prime duty of every member of such a Board is to endeavour to administer the Act honestly; or in accordance, not only with its

* Notwithstanding Mr. Huxley's intentions, the Editor took upon himself, in what seemed to him to be the public interest, to send an extract from this article to the newspapers — before the day of the election of the School Board.— EDITOR of the *Contemporary Review*.

letter, but with its spirit. And if so, it would seem that the first step toward this very desirable end is, to obtain a clear notion of what that letter signifies, and what that spirit implies; or, in other words, what the clauses of the Act are intended to enjoin and to forbid. So that it is really not admissible, except for factious and abusive purposes, to assume that any one who endeavours to get at this clear meaning is desirous only of raising quibbles and making difficulties.

Reading the Act with this desire to understand it, I find that its provisions may be classified, as might naturally be expected, under two heads: the one set relating to the subject-matter of education; the other to the establishment, maintenance, and administration of the schools in which that education is to be conducted.

Now it is a most important circumstance, that all the sections of the Act, except four, belong to the latter division; that is, they refer to mere matters of administration. The four sections in question are the seventh, the fourteenth, the sixteenth, and the ninety-seventh. Of these, the seventh, the fourteenth, and the ninety-seventh deal with the subject-matter of education, while the sixteenth defines the nature of the relations which are to exist between the "Education Department" (an euphemism for the future Minister of Education) and the School Boards. It is the sixteenth clause which is the most important, and, in some respects, the most remarkable of all. It runs thus:—

"If the School Board do, or permit, any act in contravention of, or fail to comply with, the regulations, according to which a school provided by them is required by this Act to be conducted, the Education Department may declare the School Board to be, and such Board shall accordingly be deemed to be, a Board in default, and the Education Department may proceed accordingly; and every act, or omission, of any member of the School Board, or manager appointed by them, or any person under the control of the Board, shall be deemed to be permitted by the Board, unless the contrary be proved.

"If any dispute arises as to whether the School Board have done, or permitted, any act in contravention of, or have failed to comply with, the said regulations, *the matter shall be referred to the Education Department, whose decision thereon shall be final.*"

It will be observed that this clause gives the Minister of Education absolute power over the doings of the School Boards. He is not only the administrator of the Act, but he is its interpreter. I had imagined that on the occurrence of a dispute, not as regards a question of pure administration, but as to the mean-

ing of a clause of the Act, a case might be taken and referred to a court of justice. But I am led to believe that the Legislature has, in the present instance, deliberately taken the power out of the hands of the judges and lodged it in those of the Minister of Education, who, in accordance with our method of making Ministers, will necessarily be a political partisan, and who may be a strong theological sectary into the bargain. And I am informed by members of Parliament who watched the progress of the Act, that the responsibility for this unusual state of things rests, not with the Government, but with the Legislature, which exhibited a singular disposition to accumulate power in the hands of the future Minister of Education, and to evade the more troublesome difficulties of the education question by leaving them to be settled between that Minister and the School Boards.

I express no opinion whether it is, or is not, desirable that such powers of controlling all the School Boards in the country should be possessed by a person who may be, like Mr. Forster, eminently likely to use these powers justly and wisely, but who also may be quite the reverse. I merely wish to draw attention to the fact that such powers are given to the Minister, whether he be fit or unfit. The extent of these powers becomes apparent when the other sections of the Act referred to are considered. The fourth clause of the seventh section says:—

"The school shall be conducted in accordance with the conditions required to be fulfilled by an elementary school in order to obtain an annual Parliamentary grant."

What these conditions are appears from the following clauses of the ninety-seventh section:—

"The conditions required to be fulfilled by an elementary school in order to obtain an annual Parliamentary grant shall be those contained in the minutes of the Education Department in force for the time being. Provided that no such minute of the Education Department, not in force at the time of the passing of this Act, shall be deemed to be in force until it has lain for not less than one month on the table of both Houses of Parliament."

Let us consider how this will work in practice. A school established by a School Board may receive support from three sources—from the rates, the school fees, and the Parliamentary grant. The latter may be as great as the two former taken together; and as it may be assumed, without much risk of error, that a constant pressure will be exerted by the ratepayers on the

members who represent them to get as much out of the Government, and as little out of the rates, as possible, the School Boards will have a very strong motive for shaping the education they give, as nearly as may be, on the model which the Education Minister offers for their imitation, and for the copying of which he is prepared to pay.

The Revised Code did not compel any schoolmaster to leave off teaching anything; but, by the very simple process of refusing to pay for many kinds of teaching, it has practically put an end to them. Mr. Forster is said to be engaged in revising the Revised Code; a successor of his may re-revise it — and there will be no sort of check upon these revisions and counter revisions, except the possibility of a Parliamentary debate, when the revised, or added, minutes are laid upon the table. What chance is there that any such debate will take place on a matter of detail relating to elementary education — a subject with which members of the Legislature, having been, for the most part, sent to our public schools, thirty years ago, have not the least practical acquaintance, and for which they care nothing, unless it derives a political value from its connection with sectarian politics?

I cannot but think, then, that the School Boards will have the appearance, but not the reality, of freedom of action, in regard to the subject-matter of what is commonly called "secular" education.

As respects what is commonly called "religious" education, the power of the Minister of Education is even more despotic. An interest, almost amounting to pathos, attaches itself, in my mind, to the frantic exertions which are at present going on in almost every school division, to elect certain candidates whose names have never before been heard of in connection with education, and who are either sectarian partisans, or nothing. In my own particular division, a body organised *ad hoc* is moving heaven and earth to get the seven seats filled by seven gentlemen, four of whom are good Churchmen, and three no less good Dissenters. But why should this seven times heated fiery furnace of theological zeal be so desirous to shed its genial warmth over the London School Board? Can it be that these zealous sectaries mean to evade the solemn pledge given in the Act?

> "No religious catechism or religious formula which is distinctive of any particular denomination shall be taught in the school."

I confess I should have thought it my duty to reject any such suggestion, as dishonouring to a number of worthy persons, if it

had not been for a leading article and some correspondence which appeared in the *Guardian*.

The *Guardian* is, as everybody knows, one of the best of the "religious" newspapers; and, personally, I have every reason to speak highly of the fairness, and indeed kindness, with which the editor is good enough to deal with a writer who must, in many ways, be so objectionable to him as myself. I quote the following passages from a leading article on a letter of mine, therefore, with all respect, and with a genuine conviction that the course of conduct advocated by the writer must appear to him in a very different light from that under which I see it:—

"The first of these points is the interpretation which Professor Huxley puts on the 'Cowper-Temple clause.' It is, in fact, that which we foretold some time ago as likely to be forced upon it by those who think with him. The clause itself was one of those compromises which it is very difficult to define or to maintain logically. On the one side was the simple freedom to School Boards to establish what schools they pleased, which Mr. Forster originally gave, but against which the Nonconformists lifted up their voices, because they conceived it likely to give too much power to the Church. On the other side there was the proposition to make the schools secular — intelligible enough, but in the consideration of public opinion simply impossible — and there was the vague impracticable idea, which Mr. Gladstone thoroughly tore to pieces, of enacting that the teaching of all school-masters in the new schools should be strictly 'undenominational.' The Cowper-Temple clause was, we repeat, proposed simply to tide over the difficulty. It was to satisfy the Nonconformists and the 'unsectarian,' as distinct from the secular party of the League, by forbidding all distinctive 'catechisms and formularies,' which might have the effect of openly assigning the schools to this or that religious body. It refused, at the same time, to attempt the impossible task of defining what was undenominational; and its author even contended, if we understood him correctly, that it would in no way, even indirectly, interfere with the substantial teaching of any master in any school. This assertion we always believed to be untenable; we could not see how, in the face of this clause, a distinctly denominational tone could be honestly given to schools nominally general. But beyond this mere suggestion of an attempt at a general tone of comprehensiveness in religious teaching it was not intended to go, and only because such was its limitation was it accepted by the Government and by the House.

"But now we are told that it is to be construed as doing precisely that which it refused to do. A 'formulary,' it seems, is a collection of formulas, and formulas are simply propositions of whatever kind touching religious faith. All such propositions, if they cannot be accepted by all Christian denominations, are to be proscribed; and it is added significantly that the Jews also are a denomination, and so that any teaching distinctively Christian is perhaps to be excluded, lest it should interfere with their freedom and rights. Are we then to fall back on the simple

reading of the letter of the Bible? No! this, it is granted, would be an 'unworthy pretence.' The teacher is to give 'grammatical, geographical, or historical explanations;' but he is to keep clear of 'theology proper,' because, as Professor Huxley takes great pains to prove, there is no theological teaching which is not opposed by some sect or other, from Roman Catholicism on the one hand to Unitarianism on the other. It was not, perhaps, hard to see that this difficulty would be started; and to those who, like Professor Huxley, look at it theoretically, without much practical experience of schools, it may appear serious or unanswerable. But there is very little in it practically; when it is faced determinately and handled firmly, it will soon shrink into its true dimensions. The class who are least frightened at it are the school teachers, simply because they know most about it. It is quite clear that the school managers must be cautioned against allowing their schools to be made places of proselytism; but when this is done, the case is simple enough. Leave the masters under this general understanding to teach freely; if there is ground of complaint, let it be made, but leave the *onus probandi* on the objectors. For extreme peculiarities of belief or unbelief there is the Conscience Clause; as to the mass of parents, they will be more anxious to have religion taught than afraid of its assuming this or that particular shade. They will trust the school managers and teachers till they have reason to distrust them, and experience has shown that they may trust them safely enough. Any attempt to throw the burden of making the teaching undenominational upon the managers must be sternly resisted: it is simply evading the intentions of the Act in an elaborate attempt to carry them out. We thank Professor Huxley for the warning. To be forwarned is to be forearmed."

A good deal of light seems to me to be thrown on the practical significance of the opinions expressed in the foregoing extract by the following interesting letter, which appeared in the same paper:—

"SIR,—I venture to send to you the substance of a correspondence with the Education Department upon the question of the lawfulness of religious teaching in rate schools under section 14 (2) of the Act. I asked whether the words 'which is distinctive,' etc., taken grammatically as limiting the prohibition of any religious formulary, might be construed as allowing (subject, however, to the other provisions of the Act) any religious formulary common to any two denominations anywhere in England to be taught in such schools; and if practically the limit could not be so extended, but would have to be fixed according to the special circumstances of each district, then what degree of general acceptance in a district would exempt such a formulary from the prohibition? The answer to this was as follows:—'It was understood, when clause 14 of the Education Act was discussed in the House of Commons, that, according to a well-known rule of interpreting Acts of Parliament, "denomination" must be held to include "denominations." When any dispute is referred to the Education Department

under the last paragraph of section 16, it will be dealt with according to the circumstances of the case.'

"Upon my asking further if I might hence infer that the lawfulness of teaching any religious formulary in a rate school would thus depend *exclusively* on local circumstances, and would accordingly be so decided by the Education Department in case of dispute, I was informed in explanation that 'their lordships'' letter was intended to convey to me that no general rule, beyond that stated in the first paragraph of their letter, could at present be laid down by them; and that their decision in each particular case must depend on the special circumstances accompanying it.

"I think it would appear from this that it may yet be in many cases both lawful and expedient to teach religious formularies in rate schools.

H. I.

Of course I do not mean to suggest that the editor of the *Guardian* is bound by the opinions of his correspondent; but I cannot help thinking that I do not misrepresent him, when I say that he also thinks "that it may yet be, in many cases, both lawful and expedient to teach religious formularies in rate schools under these circumstances."

It is not uncharitable, therefore, to assume that, the express words of the Act of Parliament notwithstanding, all the sectaries who are toiling so hard for seats in the London School Board have the lively hope of the gentleman from Steyning, that it may be "both lawful and expedient to teach religious formularies in rate schools"; and that they mean to do their utmost to bring this happy consummation about.*

Now the pathetic emotion to which I have referred, as accompanying my contemplations of the violent struggles of so many excellent persons, is caused by the circumstance that, so far as I can judge, their labour is in vain.

Supposing that the London School Board contains, as it probably will do, a majority of sectaries; and that they carry over the heads of a minority, a resolution that certain theological formulas,

* A passage in an article on the "Working of the Education Act," in the *Saturday Review* completely justifies this anticipation of the line of action which the sectaries mean to take. After commending the Liverpool compromise, the writer goes on to say:—

"If this plan is fairly adopted in Liverpool, the fourteenth clause of the Act will in effect be restored to its original form, and the majority of the ratepayers in each district be permitted to decide to what denomination the school shall belong."

In a previous paragraph the writer speaks of a possible "mistrust" of one another by the members of the Board, and seems to anticipate "accusations of dishonesty." If any of the members of the Board adopt his views, I think it highly probable that he may turn out to be a true prophet.

about which they all happen to agree,—say, for example, the doctrine of the Trinity,—shall be taught in the schools. Do they fondly imagine that the minority will not at once dispute their interpretation of the Act, and appeal to the Education Department to settle that dispute? And if so, do they suppose that any Minister of Education, who wants to keep his place, will tighten boundaries which the Legislature has left loose; and will give a "final decision" which shall be offensive to every Unitarian and to every Jew in the House of Commons, besides creating a precedent which will afterwards be used to the injury of every Nonconformist? The editor of the *Guardian* tells his friends sternly to resist every attempt to throw the burden of making the teaching undenominational on the managers, and thanks me for the warning I have given him. I return the thanks, with interest, for *his* warning, as to the course the party he represents intends to pursue, and for enabling me thus to draw public attention to a perfectly constitutional and effectual mode of checkmating them.

And, in truth, it is wonderful to note the surprising entanglement into which our able editor gets himself in the struggle between his native honesty and judgment and the necessities of his party. "We could not see," says he, "in the face of this clause how a distinct denominational tone could be honestly given to schools nominally general." There speaks the honest and clear-headed man. "Any attempt to throw the burden of making the teaching undenominational must be sternly resisted." There speaks the advocate holding a brief for his party. "Verily," as Trinculo says, "the monster hath two mouths:" the one, the forward mouth, tells us very justly that the teaching cannot "honestly" be "distinctly denominational"; but the other, the backward mouth, asserts that it must by no manner of means be "undenominational." Putting the two utterances together, I can only interpret them to mean that the teaching is to be "indistinctly denominational." If the editor of the *Guardian* had not shown signs of anger at my use of the term "theological fog," I should have been tempted to suppose it must have been what he had in his mind, under the name of "indistinct denominationalism." But this reading being plainly inadmissible, I can only imagine that he inculcates the teaching of formulas common to a number of denominations.

But the Education Department has already told the gentleman from Steyning that any such proceeding will be illegal. "According to a well-known rule of interpreting Acts of Parliament, 'denomination' would be held to include 'denominations.'" In other words, we must read the Act thus:—

"No religious catechism or religious formulary which is distinctive of any particular *denominations* shall be taught."

Thus we are really very much indebted to the editor of the *Guardian* and his correspondent. The one has shown us that the sectaries mean to try to get as much denominational teaching as they can agree upon among themselves, forced into the elementary schools; while the other has obtained a formal declaration from the Educational Department that any such attempt will contravene the Act of Parliament, and that, therefore, the unsectarian, law-abiding members of the School Boards may safely reckon upon bringing down upon their opponents the heavy hand of the Minister of Education.*

So much for the powers of the School Boards. Limited as they seem to be, it by no means follows that such Boards, if they are composed of intelligent and practical men, really more in earnest about education than about sectarian squabbles, may not exert a very great amount of influence. And, from many circumstances, this is especially likely to be the case with the London School Board, which, if it conducts itself wisely, may become a true educational parliament, as subordinate in authority to the Minister of Education, theoretically, as the Legislature is to the Crown, and yet, like the Legislature, possessed of great practical authority. And I suppose that no Minister of Education would be other than glad to have the aid of the deliberations of such a body, or fail to pay careful attention to its recommendations.

What, then, ought to be the nature and scope of the education which a School Board should endeavour to give to every child under its influence, and for which it should try to obtain the aid of the parliamentary grants? In my judgment it should include at least the following kinds of instruction and of discipline:—

1. Physical training and drill, as part of the regular business of the school.

It is impossible to insist too much on the importance of this part of education for the children of the poor of great towns. All the conditions of their lives are unfavourable to their physical well-being. They are badly lodged, badly housed, badly fed, and live from one year's end to another in bad air, without chance of

* Since this paragraph was written, Mr. Forster, in speaking at the Birkbeck Institution, has removed all doubts as to what his "final decision" will be in the case of such disputes being referred to him:—"I have the fullest confidence that in the reading and explaining of the Bible, what the children will be taught will be the great truths of Christian life and conduct, which all of us desire they should know, and that no effort will be made to cram into their poor little minds, theological dogmas which their tender age prevents them from understanding."

a change. They have no play-grounds; they amuse themselves with marbles and chuck-farthing, instead of cricket or hare-and-hounds; and if it were not for the wonderful instinct which leads all poor children of tender years to run under the feet of cab-horses whenever they can, I know not how they would learn to use their limbs with agility.

Now there is no real difficulty about teaching drill and the simpler kinds of gymnastics. It is done admirably well, for example, in the North Surrey Union schools; and a year or two ago when I had an opportunity of inspecting these schools, I was greatly struck with the effect of such training upon the poor little waifs and strays of humanity, mostly picked out of the gutter, who are being made into cleanly, healthy, and useful members of society in that excellent institution.

Whatever doubts people may entertain about the efficacy of natural selection, there can be none about artificial selection; and the breeder who should attempt to make, or keep up, a fine stock of pigs, or sheep, under the conditions to which the children of the poor are exposed, would be the laughing-stock even of the bucolic mind. Parliament has already done something in this direction by declining to be an accomplice in the asphyxiation of school children. It refuses to make any grant to a school in which the cubical contents of the school-room are inadequate to allow of proper respiration. I should like to see it make another step in the same direction, and either refuse to give a grant to a school in which physical training is not a part of the programme, or, at any rate, offer to pay upon such training. If something of the kind is not done, the English physique, which has been, and is still, on the whole, a grand one, will become as extinct as the dodo in the great towns.

And then the moral and intellectual effect of drill, as an introduction to, and aid of, all other sorts of training, must not be overlooked. If you want to break in a colt, surely the first thing to do is to catch him and get him quietly to face his trainer; to know his voice and bear his hand; to learn that colts have something else to do with their heels than to kick them up whenever they feel so inclined; and to discover that the dreadful human figure has no desire to devour, or even to beat him, but that, in case of attention and obedience, he may hope for patting and even a sieve of oats.

But, your "street Arabs," and other neglected poor children, are rather worse and wilder than colts; for the reason that the horse-colt has only his animal instincts in him, and his mother, the mare, has been always tender over him, and never came home

drunk and kicked him in her life; while the man-colt is inspired by that very real devil, perverted manhood, and *his* mother may have done all that and more. So, on the whole, it may probably be even more expedient to begin your attempt to get at the higher nature of the child, than at that of the colt, from the physical side.

2. Next in order to physical training I put the instruction of children, and especially of girls, in the elements of household work and of domestic economy; in the first place for their own sakes, and in the second for that of their future employers.

Every one who knows anything of the life of the English poor is aware of the misery and waste caused by their want of knowledge of domestic economy, and by their lack of habits of frugality and method. I suppose it is no exaggeration to say that a poor Frenchwoman would make the money which the wife of a poor Englishman spends in food go twice as far, and at the same time turn out twice as palatable a dinner. Why Englishmen, who are so notoriously fond of good living, should be so hopelessly incompetent in the art of cookery, is one of the great mysteries of nature; but from the varied abominations of the railway refreshment-rooms to the monotonous dinners of the poor, English feeding is either wasteful or nasty, or both.

And as to domestic service, the groans of the housewives of England ascend to heaven! In five cases out of six the girl who takes a "place" has to be trained by her mistress in the first rudiments of decency and order; and it is a mercy if she does not turn up her nose at anything like the mention of an honest and proper economy. Thousands of young girls are said to starve, or worse, yearly in London; and at the same time thousands of mistresses of households are ready to pay high wages for a decent housemaid, or cook, or a fair workwoman; and can by no means get what they want.

Surely, if the elementary schools are worth anything, they may put an end to a state of things which is demoralising the poor, while it is wasting the lives of those better off in small worries and annoyances.

3. But the boys and girls for whose education the School Boards have to provide, have not merely to discharge domestic duties, but each of them is a member of a social and political organisation of great complexity, and has, in future life, to fit himself into that organisation, or be crushed by it. To this end it is surely needful, not only that they should be made acquainted with the elementary laws of conduct, but that their affections should be trained, so as to love with all their hearts that conduct which

tends to the attainment of the highest good for themselves and their fellow men, and to hate with all their hearts that opposite course of action which is fraught with evil.

So far as the laws of conduct are determined by the intellect, I apprehend that they belong to science, and to that part of science which is called morality. But the engagement of the affections in favour of that particular kind of conduct which we call good, seems to me to be something quite beyond mere science. And I cannot but think that it, together with the awe and reverence, which have no kinship with base fear, but arise whenever one tries to pierce below the surface of things, whether they be material or spiritual, constitutes all that has any unchangeable reality in religion.

And just as I think it would be a mistake to confound the science, morality, with the affection, religion; so do I conceive it to be a most lamentable and mischievous error, that the science, theology, is so confounded in the minds of many — indeed, I might say, of the majority of men.

I do not express any opinion as to whether theology is a true science, or whether it does not come under the apostolic definition of "science falsely so called"; though I may be permitted to express the belief that if the Apostle to whom that much misapplied phrase is due could make the acquaintance of much of modern theology, he would not hesitate a moment in declaring that it is exactly what he meant the words to denote.

But it is at any rate conceivable, that the nature of the Deity, and his relations to the universe, and more especially to mankind, are capable of being ascertained, either inductively or deductively, or by both processes. And, if they have been ascertained, then a body of science has been formed which is very properly called theology.

Further, there can be no doubt that affection for the Being thus defined and described by theologic science would be properly termed religion; but it would not be the whole of religion. The affection for the ethical ideal defined by moral science would claim equal if not superior rights. For suppose theology established the existence of an evil deity — and some theologies, even Christian ones, have come very near this,— is the religious affection to be transferred from the ethical ideal to any such omnipotent demon? I trow not. Better a thousand times that the human race should perish under his thunderbolts than it should say, "Evil, be thou my good."

There is nothing new, that I know of, in this statement of the relations of religion with the science of morality on the one hand

and that of theology on the other. But I believe it to be altogether true, and very needful, at this time, to be clearly and emphatically recognised as such, by those who have to deal with the education question.

We are divided into two parties — the advocates of so-called "religious" teaching on the one hand, and those of so-called "secular" teaching on the other. And both parties seem to me to be not only hopelessly wrong, but in such a position that if either succeeded completely, it would discover, before many years were over, that it had made a great mistake and done serious evil to the cause of education.

For, leaving aside the more far-seeing minority on each side, what the "religious" party is crying for is mere theology, under the name of religion; while the "secularists" have unwisely and wrongfully admitted the assumption of their opponents, and demand the abolition of all "religious" teaching, when they only want to be free of theology — Burning your ship to get rid of the cockroaches!

But my belief is, that no human being, and no society composed of human beings, ever did, or ever will, come to much, unless their conduct was governed and guided by the love of some ethical idea. Undoubtedly, your gutter child may be converted by mere intellectual drill into "the subtlest of all the beasts of the field"; but we know what has become of the original of that description, and there is no need to increase the number of those who imitate him successfully without being aided by the rates. And if I were compelled to choose for one of my own children, between a school in which real religious instruction is given, and one without it, I should prefer the former, even though the child might have to take a good deal of theology with it. Nine-tenths of a dose of bark is mere half-rotten wood; but one swallows it for the sake of the particles of quinine, the beneficial effect of which may be weakened, but is not destroyed, by the wooden dilution, unless in a few cases of exceptionally tender stomachs.

Hence, when the great mass of the English people declare that they want to have the children in the elementary schools taught the Bible, and when it is plain from the terms of the Act, the debates in and out of Parliament, and especially the emphatic declarations of the Vice-President of the Council, that it was intended that such Bible-reading should be permitted, unless good cause for prohibiting it could be shown, I do not see what reason there is for opposing that wish. Certainly, I, individually, could with no shadow of consistency oppose the teaching of the children of other people to do that which my own children are taught to

do. And, even if the reading the Bible were not, as I think it is, consonant with political reason and justice, and with a desire to act in the spirit of the education measure, I am disposed to think it might still be well to read that book in the elementary schools.

I have always been strongly in favour of secular education, in the sense of education without theology; but I must confess I have been no less seriously perplexed to know by what practical measures the religious feeling, which is the essential basis of conduct, was to be kept up, in the present utterly chaotic state of opinion on these matters, without the use of the Bible. The Pagan moralists lack life and colour, and even the noble Stoic, Marcus Aurelius, is too high and refined for an ordinary child. Take the Bible as a whole; make the severest deductions which fair criticism can dictate for shortcomings and positive errors; eliminate, as a sensible lay-teacher would do, if left to himself, all that it is not desirable for children to occupy themselves with; and there still remains in this old literature a vast residuum of moral beauty and grandeur. And then consider the great historical fact that, for three centuries, this book has been woven into the life of all that is best and noblest in English history; that it has become the national epic of Britain, and is as familiar to noble and simple, from John-o'-Groat's House to Land's End, as Dante and Tasso once were to the Italians; that it is written in the noblest and purest English, and abounds in exquisite beauties of mere literary form; and, finally, that it forbids the veriest hind who never left his village to be ignorant of the existence of other countries and other civilisations, and of a great past, stretching back to the furthest limits of the oldest nations in the world. By the study of what other book could children be so much humanised and made to feel that each figure in that vast historical procession fills, like themselves, but a momentary space in the interval between two eternities; and earns the blessings or the curses of all time, according to its effort to do good and hate evil, even as they also are earning their payment for their work?

On the whole, then, I am in favour of reading the Bible, with such grammatical, geographical, and historical explanations by a lay-teacher as may be needful, with rigid exclusion of any further theological teaching than that contained in the Bible itself. And in stating what this is, the teacher would do well not to go beyond the precise words of the Bible; for if he does, he will, in the first place, undertake a task beyond his strength, seeing that all the Jewish and Christian sects have been at work upon that sub-

ject for more than two thousand years, and have not yet arrived, and are not in the least likely to arrive, at an agreement; and, in the second place, he will certainly begin to teach something distinctively denominational, and thereby come into violent collision with the Act of Parliament.

4. The intellectual training to be given in the elementary schools must of course, in the first place, consist in learning to use the means of acquiring knowledge, or reading, writing, and arithmetic; and it will be a great matter to teach reading so completely that the act shall have become easy and pleasant. If reading remains "hard," that accomplishment will not be much resorted to for instruction, and still less for amusement — which last is one of its most valuable uses to hard-worked people. But along with a due proficiency in the use of the means of learning, a certain amount of knowledge, of intellectual discipline, and of artistic training should be conveyed in the elementary schools; and in this direction — for reasons which I am afraid to repeat, having urged them so often — I can conceive no subject-matter of education so appropriate and so important as the rudiments of physical science, with drawing, modelling, and singing. Not only would such teaching afford the best possible preparation for the technical schools about which so much is now said, but the organisation for carrying it into effect already exists. The Science and Art Department, the operations of which have already attained considerable magnitude, not only offers to examine and pay the results of such examination in elementary science and art, but it provides what is still more important, viz. a means of giving children of high natural ability, who are just as abundant among the poor as among the rich, a helping hand. A good old proverb tells us that "One should not take a razor to cut a block:" the razor is soon spoiled, and the block is not so well cut as it would be with a hatchet. But it is worse economy to prevent a possible Watt from being anything but a stoker, or to give a possible Faraday no chance of doing anything but to bind books. Indeed, the loss in such cases of mistaken vocation has no measure; it is absolutely infinite and irreparable. And among the arguments in favour of the interference of the State in education, none seems to be stronger than this — that it is the interest of every one that ability should be neither wasted, nor misapplied, by any one: and, therefore, that every one's representative, the State, is necessarily fulfilling the wishes of its constituents when it is helping the capacities to reach their proper places.

It may be said that the scheme of education here sketched is too large to be effected in the time during which the children will

remain at school; and, secondly, that even if this objection did not exist, it would cost too much.

I attach no importance whatever to the first objection until the experiment has been fairly tried. Considering how much catechism, lists of the kings of Israel, geography of Palestine, and the like, children are made to swallow now, I cannot believe there will be any difficulty in inducing them to go through the physical training, which is more than half play; or the instruction in household work, or in those duties to one another and to themselves, which have a daily and hourly practical interest. That children take kindly to elementary science and art no one can doubt who has tried the experiment properly. And if Bible-reading is not accompanied by constraint and solemnity, as if it were a sacramental operation, I do not believe there is anything in which children take more pleasure. At least I know that some of the pleasantest recollections of my childhood are connected with the voluntary study of an ancient Bible which belonged to my grandmother. There were splendid pictures in it, to be sure; but I recollect little or nothing about them save a portrait of the high priest in his vestments. What come vividly back on my mind are remembrances of my delight in the histories of Joseph and of David; and of my keen appreciation of the chivalrous kindness of Abraham in his dealing with Lot. Like a sudden flash there returns back upon me, my utter scorn of the pettifogging meanness of Jacob, and my sympathetic grief over the heartbreaking lamentation of the cheated Esau, "Hast thou not a blessing for me also, O my father?" And I see, as in a cloud, pictures of the grand phantasmagoria of the Book of Revelation.

I enumerate, as they issue, the childish impressions which come crowding out of the pigeon-holes in my brain, in which they have lain almost undisturbed for forty years. I prize them as an evidence that a child of five or six years old, left to his own devices, may be deeply interested in the Bible, and draw sound moral sustenance from it. And I rejoice that I was left to deal with the Bible alone; for if I had had some theological "explainer" at my side, he might have tried, as such do, to lessen my indignation against Jacob, and thereby have warped my moral sense for ever; while the great apocalyptic spectacle of the ultimate triumph of right and justice might have been turned to the base purposes of a pious lampooner of the Papacy.

And as to the second objection — costliness — the reply is, first, that the rate and the Parliamentary grant together ought to be enough, considering that science and art teaching is already pro-

vided for; and, secondly, that if they are not, it may be well for the educational parliament to consider what has become of those endowments which were originally intended to be devoted, more or less largely, to the education of the poor.

When the monasteries were spoiled, some of their endowments were applied to the foundation of cathedrals; and in all such cases it was ordered that a certain portion of the endowment should be applied to the purposes of education. How much is so applied? Is that which may be so applied given to help the poor, who cannot pay for education, or does it virtually subsidise the comparatively rich, who can? How are Christ's Hospital and Alleyn's foundation securing their right purposes, or how far are they perverted into contrivances for affording relief to the classes who can afford to pay for education? How — But this paper is already too long, and, if I begin, I may find it hard to stop asking questions of this kind, which after all are worthy only of the lowest of Radicals.

XVI.

TECHNICAL EDUCATION.

ANY candid observer of the phenomena of modern society will readily admit that bores must be classed among the enemies of the human race; and a little consideration will probably lead him to the further admission, that no species of that extensive genus of noxious creatures is more objectionable than the educational bore. Convinced as I am of the truth of this great social generalisation, it is not without a certain trepidation that I venture to address you on an educational topic. For, in the course of the last ten years, to go back no farther, I am afraid to say how often I have ventured to speak of education, from that given in the primary schools to that which is to be had in the universities and medical colleges; indeed, the only part of this wide region into which, as yet, I have not adventured is that into which I propose to intrude to-day.

Thus, I cannot but be aware that I am dangerously near becoming the thing which all men fear and fly. But I have deliberately elected to run the risk. For when you did me the honour to ask me to address you, an unexpected circumstance had led me to occupy myself seriously with the question of technical education; and I had acquired the conviction that there are few subjects respecting which it is more important for all classes of the community to have clear and just ideas than this; while, certainly, there is none which is more deserving of attention by the Working Men's Club and Institute Union.

It is not for me to express an opinion whether the considerations, which I am about to submit to you, will be proved by experience to be just or not, but I will do my best to make them clear. Among the many good things to be found in Lord Bacon's works, none is more full of wisdom than the saying that "truth more easily comes out of error than out of confusion." Clear and consecutive wrong-thinking is the next best thing to right-thinking; so that, if I succeed in clearing your ideas on this topic, I shall have wasted neither your time nor my own.

"Technical education," in the sense in which the term is ordinarily used, and in which I am now employing it, means that sort of education which is specially adapted to the needs of men whose business in life it is to pursue some kind of handicraft; it is, in fact, a fine Greco-Latin equivalent for what in good vernacular English would be called the "teaching of handicrafts." And probably, at this stage of our progress, it may occur to many of you to think of the story of the cobbler and his last, and to say to yourselves, though you will be too polite to put the question openly to me, What does the speaker know practically about this matter? What is his handicraft? I think the question is a very proper one, and unless I were prepared to answer it, I hope satisfactorily, I should have chosen some other theme.

The fact is, I am, and have been, any time these thirty years, a man who works with his hands — a handicraftsman. I do not say this in the broadly metaphorical sense in which fine gentlemen, with all the delicacy of Agag about them, trip to the hustings about election time, and protest that they too are working men. I really mean my words to be taken in their direct, literal, and straightforward sense. In fact, if the most nimble-fingered watchmaker among you will come to my workshop, he may set me to put a watch together, and I will set him to dissect, say, a blackbeetle's nerves. I do not wish to vaunt, but I am inclined to think that I shall manage my job to his satisfaction sooner than he will do his piece of work to mine.

In truth, anatomy, which is my handicraft, is one of the most difficult kinds of mechanical labour, involving, as it does, not only lightness and dexterity of hand, but sharp eyes and endless patience. And you must not suppose that my particular branch of science is especially distinguished for the demand it makes upon skill in manipulation. A similar requirement is made upon all students of physical science. The astronomer, the electrician, the chemist, the mineralogist, the botanist, are constantly called upon to perform manual operations of exceeding delicacy. The progress of all branches of physical science depends upon observation, or on that artificial observation which is termed experiment, of one kind or another; and, the farther we advance, the more practical difficulties surround the investigation of the conditions of the problems offered to us; so that mobile and yet steady hands, guided by clear vision, are more and more in request in the workshops of science.

Indeed, it has struck me that one of the grounds of that sympathy between the handicraftsmen of this country and the men of science, by which it has so often been my good fortune to profit,

may, perhaps, lie here. You feel and we feel that, among the so-called learned folks, we alone are brought into contact with tangible facts in the way that you are. You know well enough that it is one thing to write a history of chairs in general, or to address a poem to a throne, or to speculate about the occult powers of the chair of St. Peter; and quite another thing to make with your own hands a veritable chair, that will stand fair and square, and afford a safe and satisfactory resting-place to a frame of sensitiveness and solidity.

So it is with us, when we look out from our scientific handicrafts upon the doings of our learned brethren, whose work is untrammelled by anything "base and mechanical," as handicrafts used to be called when the world was younger, and, in some respects, less wise than now. We take the greatest interest in their pursuits; we are edified by their histories and are charmed with their poems, which sometimes illustrate so remarkably the powers of man's imagination; some of us admire and even humbly try to follow them in their high philosophical excursions, though we know the risk of being snubbed by the inquiry whether grovelling dissectors of monkeys and blackbeetles can hope to enter into the empyreal kingdom of speculation. But still we feel that our business is different; humbler if you will, though the diminution of dignity is, perhaps, compensated by the increase of reality; and that we, like you, have to get our work done in a region where little avails, if the power of dealing with practical tangible facts is wanting. You know that clever talk touching joinery will not make a chair; and I know that it is of about as much value in the physical sciences. Mother Nature is serenely obdurate to honeyed words; only those who understand the ways of things, and can silently and effectually handle them, get any good out of her.

And now, having, as I hope, justified my assumption of a place among handicraftsmen, and put myself right with you as to my qualification, from practical knowledge, to speak about technical education, I will proceed to lay before you the results of my experience as a teacher of a handicraft, and tell you what sort of education I should think best adapted for a boy whom one wanted to make a professional anatomist.

I should say, in the first place, let him have a good English elementary education. I do not mean that he shall be able to pass in such and such a standard — that may or may not be an equivalent expression — but that his teaching shall have been such as to have given him command of the common implements of learning and to have created a desire for the things of the understanding.

Further, I should like him to know the elements of physical science, and especially of physics and chemistry, and I should take care that this elementary knowledge was real. I should like my aspirant to be able to read a scientific treatise in Latin, French, or German, because an enormous amount of anatomical knowledge is locked up in those languages. And especially, I should require some ability to draw — I do not mean artistically, for that is a gift which may be cultivated but cannot be learned, but with fair accuracy. I will not say that everybody can learn even this; for the negative development of the faculty of drawing in some people is almost miraculous. Still everybody, or almost everybody, can learn to write; and, as writing is a kind of drawing, I suppose that the majority of the people who say they cannot draw, and give copious evidence of the accuracy of their assertion, could draw, after a fashion, if they tried. And that "after a fashion" would be better than nothing for my purposes.

Above all things, let my imaginary pupil have preserved the freshness and vigour of youth in his mind as well as his body. The educational abomination of desolation of the present day is the stimulation of young people to work at high pressure by incessant competitive examinations. Some wise man (who probably was not an early riser) has said of early risers in general, that they are conceited all the forenoon and stupid all the afternoon. Now whether this is true of early risers in the common acceptation of the word or not, I will not pretend to say; but it is too often true of the unhappy children who are forced to rise too early in their classes. They are conceited all the forenoon of life, and stupid all its afternoon. The vigour and freshness, which should have been stored up for the purposes of the hard struggle for existence in practical life, have been washed out of them by precocious mental debauchery — by book gluttony and lesson bibbing. Their faculties are worn out by the strain put upon their callow brains, and they are demoralised by worthless childish triumphs before the real work of life begins. I have no compassion for sloth, but youth has more need for intellectual rest than age; and the cheerfulness, the tenacity of purpose, the power of work which make many a successful man what he is, must often be placed to the credit, not of his hours of industry, but to that of his hours of idleness, in boyhood. Even the hardest worker of us all, if he has to deal with anything above mere details, will do well, now and again, to let his brain lie fallow for a space. The next crop of thought will certainly be all the fuller in the ear and the weeds fewer.

This is the sort of education which I should like any one who

was going to devote himself to my handicraft to undergo. As to knowing anything about anatomy itself, on the whole I would rather he left that alone until he took it up seriously in my laboratory. It is hard work enough to teach, and I should not like to have superadded to that the possible need of unteaching.

Well, but, you will say, this is Hamlet with the Prince of Denmark left out; your "technical education" is simply a good education, with more attention to physical science, to drawing, and to modern languages than is common, and there is nothing specially technical about it.

Exactly so; that remark takes us straight to the heart of what I have to say; which is, that, in my judgment, the preparatory education of the handicraftsman ought to have nothing of what is ordinarily understood by "technical" about it.

The workshop is the only real school for a handicraft. The education which precedes that of the workshop should be entirely devoted to the strengthening of the body, the elevation of the moral faculties, and the cultivation of the intelligence; and, especially, to the imbuing the mind with a broad and clear view of the laws of that natural world with the components of which the handicraftsman will have to deal. And, the earlier the period of life at which the handicraftsman has to enter into actual practice of his craft, the more important is it that he should devote the precious hours of preliminary education to things of the mind, which have no direct and immediate bearing on his branch of industry, though they lie at the foundation of all realties.

Now let me apply the lessons I have learned from my handicraft to yours. If any of you were obliged to take an apprentice, I suppose you would like to get a good healthy lad, ready and willing to learn, handy, and with his fingers not all thumbs, as the saying goes. You would like that he should read, write, and cipher well; and, if you were an intelligent master, and your trade involved the application of scientific principles, as so many trades do, you would like him to know enough of the elementary principles of science to understand what was going on. I suppose that, in nine trades out of ten, it would be useful if he could draw; and many of you must have lamented your inability to find out for yourselves what foreigners are doing or have done. So that some knowledge of French and German might, in many cases, be very desirable.

So it appears to me that what you want is pretty much what I want; and the practical question is, How you are to get what

you need, under the actual limitations and conditions of life of handicraftsmen in this country?

I think I shall have the assent both of the employers of labour and of the employed as to one of these limitations; which is, that no scheme of technical education is likely to be seriously entertained which will delay the entrance of boys into working life, or prevent them from contributing towards their own support, as early as they do at present. Not only do I believe that any such scheme could not be carried out, but I doubt its desirableness, even if it were practicable.

The period between childhood and manhood is full of difficulties and dangers, under the most favourable circumstances; and, even among the well-to-do, who can afford to surround their children with the most favourable conditions, examples of a career ruined, before it has well begun, are but too frequent. Moreover, those who have to live by labour must be shaped to labour early. The colt that is left at grass too long makes but a sorry draught-horse, though his way of life does not bring him within the reach of artificial temptations. Perhaps the most valuable result of all education is the ability to make yourself do the thing you have to do, when it ought to be done, whether you like it or not; it is the first lesson that ought to be learned; and, however early a man's training begins, it is probably the last lesson that he learns thoroughly.

There is another reason, to which I have already adverted, and which I would reiterate, why any extension of the time devoted to ordinary school-work is undesirable. In the newly-awakened zeal for education, we run some risk of forgetting the truth that while under-instruction is a bad thing, over-instruction may possibly be a worse.

Success in any kind of practical life is not dependent solely, or indeed chiefly, upon knowledge. Even in the learned professions, knowledge alone, is of less consequence than people are apt to suppose. And, if much expenditure of bodily energy is involved in the day's work, mere knowledge is of still less importance when weighed against the probable cost of its acquirement. To do a fair day's work with his hands, a man needs, above all things, health, strength, and the patience and cheerfulness which, if they do not always accompany these blessings, can hardly in the nature of things exist without them; to which we must add honesty of purpose and a pride in doing what is done well.

A good handicraftsman can get on very well without genius, but he will fare badly without a reasonable share of that which is a more useful possession for a workaday life, namely, mother-

wit; and he will be all the better for a real knowledge, however limited, of the ordinary laws of nature, and especially those which apply to his own business.

Instruction carried so far as to help the scholar to turn his store of mother-wit to account, to acquire a fair amount of sound elementary knowledge, and to use his hands and eyes, while leaving him fresh, vigorous, and with a sense of the dignity of his own calling, whatever it may be, if fairly and honestly pursued, cannot fail to be of invaluable service to all those who come under its influence.

But, on the other hand, if school instruction is carried so far as to encourage bookishness; if the ambition of the scholar is directed, not to the gaining of knowledge, but to the being able to pass examinations successfully; especially if encouragement is given to the mischievous delusion that brainwork is, in itself, and apart from its quality, a nobler or more respectable thing than handiwork — such education may be a deadly mischief to the workman, and lead to the rapid ruin of the industries it is intended to serve.

I know that I am expressing the opinion of some of the largest as well as the most enlightened employers of labour, when I say that there is a real danger that, from the extreme of no education, we may run to the other extreme of over-education of handicraftsmen. And I apprehend that what is true for the ordinary handworker is true for the foreman. Activity, probity, knowledge of men, ready mother-wit supplemented by a good knowledge of the general principles involved in his business, are the making of a good foreman. If he possess these qualities, no amount of learning will fit him better for his position; while the course of life and the habit of mind required for the attainment of such learning may, in various direct and indirect ways, act as disqualifications for it.

Keeping in mind, then, that the two things to be avoided are, the delay of the entrance of boys into practical life, and the substitution of exhausted bookworms for shrewd, handy men, in our works and factories, let us consider what may be wisely and safely attempted in the way of improving the education of the handicraftsman.

First, I look to the elementary schools now happily established all over the country. I am not going to criticise or find fault with them; on the contrary, their establishment seems to me to be the most important and the most beneficial result of the corporate action of the people in our day. A great deal is said of British interests just now, but, depend upon it, that no Eastern

difficulty needs our intervention as a nation so seriously, as the putting down both the Bashi-Bazouks of ignorance and the Cossacks of sectarianism at home. What has already been achieved in these directions is a great thing; you must have lived some time to know how great. An education, better in its processes, better in its substance, than that which was accessible to the great majority of well-to-do Britons a quarter of a century ago, is now obtainable by every child in the land. Let any man of my age go into an ordinary elementary school, and unless he was unusually fortunate in his youth, he will tell you that the educational method, the intelligence, patience, and good temper on the teacher's part, which are now at the disposal of the veriest waifs and wastrels of society, are things of which he had no experience in those costly, middle-class schools, which were so ingeniously contrived as to combine all the evils and shortcomings of the great public schools with none of their advantages. Many a man, whose so-called education cost a good deal of valuable money and occupied many a year of invaluable time, leaves the inspection of a well-ordered elementary school devoutly wishing that, in his young days, he had had the chance of being as well taught as these boys and girls are.

But while in view of such an advance in general education, I willingly obey the natural impulse to be thankful, I am not willing altogether to rest. I want to see instruction in elementary science and in art more thoroughly incorporated in the educational system. At present, it is being administered by driblets, as if it were a potent medicine, "a few drops to be taken occasionally in a teaspoon." Every year I notice that that earnest and untiring friend of yours and of mine, Sir John Lubbock, stirs up the Government of the day in the House of Commons on this subject; and also that, every year, he, and the few members of the House of Commons, such as Dr. Playfair, who sympathise with him, are met with expressions of warm admiration for science in general, and reasons at large for doing nothing in particular. But now that Mr. Forster, to whom the education of the country owes so much, has announced his conversion to the right faith, I begin to hope that, sooner or later, things will mend.

I have given what I believe to be a good reason for the assumption, that the keeping at school of boys, who are to be handicraftsmen, beyond the age of thirteen or fourteen is neither practicable nor desirable; and, as it is quite certain, that, with justice to other and no less important branches of education, nothing more than the rudiments of science and art teaching can be introduced into elementary schools, we must seek elsewhere for a

supplementary training in these subjects, and, if need be, in foreign languages, which may go on after the workman's life has begun.

The means of acquiring the scientific and artistic part of this training already exists in full working order, in the first place, in the classes of the Science and Art Department, which are, for the most part, held in the evening, so as to be accessible to all who choose to avail themselves of them after working hours. The great advantage of these classes is that they bring the means of instruction to the doors of the factories and workshops; that they are no artificial creations, but by their very existence prove the desire of the people for them; and finally, that they admit of indefinite development in proportion as they are wanted. I have often expressed the opinion, and I repeat it here, that, during the eighteen years they have been in existence these classes have done incalculable good; and I can say, of my own knowledge, that the Department spares no pains and trouble in trying to increase their usefulness and ensure the soundness of their work.

No one knows better than my friend Colonel Donnelly, to whose clear views and great administrative abilities so much of the successful working of the science classes is due, that there is much to be done before the system can be said to be thoroughly satisfactory. The instruction given needs to be made more systematic and especially more practical; the teachers are of very unequal excellence, and not a few stand much in need of instruction themselves, not only in the subject which they teach, but in the objects for which they teach. I dare say you have heard of that proceeding, reprobated by all true sportsmen, which is called "shooting for the pot." Well, there is such a thing as "teaching for the pot"—teaching, that is, not that your scholar may know, but that he may count for payment among those who pass the examination; and there are some teachers, happily not many, who have yet to learn that the examiners of the Department regard them as poachers of the worst description.

Without presuming in any way to speak in the name of the Department, I think I may say, as a matter which has come under my own observation, that it is doing its best to meet all these difficulties. It systematically promotes practical instruction in the classes; it affords facilities to teachers who desire to learn their business thoroughly; and it is always ready to aid in the suppression of pot-teaching.

All this is, as you may imagine, highly satisfactory to me. I see that spread of scientific education, about which I have so

often permitted myself to worry the public, become, for all practical purposes, an accomplished fact. Grateful as I am for all that is now being done, in the same direction, in our higher schools and universities, I have ceased to have any anxiety about the wealthier classes. Scientific knowledge is spreading by what the alchemists called a "distillatio per ascensum"; and nothing now can prevent it from continuing to distil upwards and permeate English society, until, in the remote future, there shall be no member of the legislature who does not know as much of science as an elementary school-boy; and even the heads of houses in our venerable seats of learning shall acknowledge that natural science is not merely a sort of University backdoor through which inferior men may get at their degrees. Perhaps this apocalyptic vision is a little wild; and I feel I ought to ask pardon for an outbreak of enthusiasm, which I assure you, is not my commonest failing.

I have said that the Government is already doing a great deal in aid of that kind of technical education for handicraftsmen which, to my mind, is alone worth seeking. Perhaps it is doing as much as it ought to do, even in this direction. Certainly there is another kind of help of the most important character, for which we may look elsewhere than to the Government. The great mass of mankind have neither the liking, nor the aptitude, for either literary, or scientific, or artistic pursuits; nor, indeed, for excellence of any sort. Their ambition is to go through life with moderate exertion and a fair share of ease, doing common things in a common way. And a great blessing and comfort it is that the majority of men are of this mind; for the majority of things to be done are common things, and are quite well enough done when commonly done. The great end of life is not knowledge but action. What men need is, as much knowledge as they can assimilate and organise into a basis for action; give them more and it may become injurious. One knows people who are as heavy and stupid from undigested learning as others are from over-fulness of meat and drink. But a small percentage of the population is born with that most excellent quality, a desire for excellence, or with special aptitudes of some sort or another; Mr. Galton tells us that not more than one in four thousand may be expected to attain distinction, and not more than one in a million some share of that intensity of instinctive aptitude, that burning thirst for excellence, which is called genius.

Now, the most important object of all educational schemes is to catch these exceptional people, and turn them to account for the good of society. No man can say where they will crop up;

like their opposites, the fools and knaves, they appear sometimes in the palace, and sometimes in the hovel; but the great thing to be aimed at, I was almost going to say the most important end of all social arrangements, is to keep these glorious sports of Nature from being either corrupted by luxury or starved by poverty, and to put them into the position in which they can do the work for which they are especially fitted.

Thus, if a lad in an elementary school showed signs of special capacity, I would try to provide him with the means of continuing his education after his daily working life had begun; if in the evening classes he developed special capabilities in the direction of science or of drawing, I would try to secure him an apprenticeship to some trade in which those powers would have applicability. Or, if he chose to become a teacher, he should have the chance of so doing. Finally, to the lad of genius, the one in a million, I would make accessible the highest and most complete training the country could afford. Whatever that might cost, depend upon it the investment would be a good one. I weigh my words when I say that if the nation could purchase a potential Watt, or Davy, or Faraday, at the cost of a hundred thousand pounds down, he would be dirt-cheap at the money. It is a mere commonplace and everyday piece of knowledge, that what these three men did has produced untold millions of wealth, in the narrowest economical sense of the word.

Therefore, as the sum and crown of what is to be done for technical education, I look to the provision of a machinery for winnowing out the capacities and giving them scope. When I was a member of the London School Board, I said, in the course of a speech, that our business was to provide a ladder, reaching from the gutter to the university, along which every child in the three kingdoms should have the chance of climbing as far as he was fit to go. This phrase was so much bandied about at the time, that, to say truth, I am rather tired of it; but I know of no other which so fully expresses my belief, not only about education in general, but about technical education in particular.

The essential foundation of all the organisation needed for the promotion of education among handicraftsmen will, I believe, exist in this country, when every working lad can feel that society has done as much as lies in its power to remove all needles and artificial obstacles from his path; that there is no barrier, except such as exists in the nature of things, between himself and whatever place in the social organisation he is fitted to fill; and, more than this, that, if he has capacity and industry,

a hand is held out to help him along any path which is wisely and honestly chosen.

I have endeavoured to point out to you that a great deal of such an organisation already exists; and I am glad to be able to add that there is a good prospect that what is wanting will, before long, be supplemented.

Those powerful and wealthy societies, the livery companies of the City of London, remembering that they are the heirs and representatives of the trade guilds of the Middle Ages, are interesting themselves in the question. So far back as 1872 the Society of Arts organised a system of instruction in the technology of arts and manufactures, for persons actually employed in factories and workshops, who desired to extend and improve their knowledge of the theory and practice of their particular avocations;* and a considerable subsidy, in aid of the efforts of the Society, was liberally granted by the Clothworkers' Company. We have here the hopeful commencement of a rational organisation for the promotion of excellence among handicraftsmen. Quite recently, other of the livery companies have determined upon giving their powerful, and, indeed, almost boundless, aid to the improvement of the teaching of handicrafts. They have already gone so far as to appoint a committee to act for them; and I betray no confidence in adding that, some time since, the committee sought the advice and assistance of several persons, myself among the number.

Of course I cannot tell you what may be the result of the deliberations of the committee; but we may all fairly hope that, before long, steps which will have a weighty and a lasting influence on the growth and spread of sound and thorough teaching among the handicraftsmen† of this country will be taken by the livery companies of London.

[This hope has been fully justified by the establishment of the Cowper Street Schools, and that of the Central Institution of the City and Guilds of London Institute.]

* See the *Programme* for 1878, issued by the Society of Arts, p. 14.

† It is perhaps advisable to remark that the important question of the professional education of managers of industrial works is not touched in the foregoing remarks.

XVII.

ADDRESS ON BEHALF OF THE NATIONAL ASSOCIATION FOR THE PROMOTION OF TECHNICAL EDUCATION.

MR. MAYOR AND GENTLEMEN,—It must be a matter of sincere satisfaction to those who, like myself, have for many years past been convinced of the vital importance of technical education to this country to see that that subject is now being taken up by some of the most important of our manufacturing towns. The evidence which is afforded of the public interest in the matter by such meetings as those at Liverpool and Newcastle, and, last but not least, by that at which I have the honour to be present to-day, may convince us all, I think, that the question has passed out of the region of speculation into that of action. I need hardly say to any one here that the task which our Association contemplates is not only one of primary importance —I may say of vital importance—to the welfare of the country; but that it is one of great extent and of vast difficulty. There is a well-worn adage that those who set out upon a great enterprise would do well to count the cost. I am not sure that this is always true. I think that some of the very greatest enterprises in this world have been carried out successfully simply because the people who undertook them did not count the cost; and I am much of opinion that, in this very case, the most instructive consideration for us is the cost of doing nothing. But there is one thing that is perfectly certain, and it is that, in undertaking all enterprises, one of the most important conditions of success is to have a perfectly clear comprehension of what you want to do—to have that before your minds before you set out, and from that point of view to consider carefully the measures which are best adapted to the end.

Mr. Acland has just given you an excellent account of what is properly and strictly understood by technical education; but I venture to think that the purpose of this Association may be stated in somewhat broader terms, and that the object we have in view is the development of the industrial productivity of the

country to the uttermost limits consistent with social welfare. And you will observe that, in thus widening the definition of our object, I have gone no further than the Mayor in his speech, when he not obscurely hinted — and most justly hinted — that in dealing with this question there are other matters than technical education, in the strict sense, to be considered.

It would be extreme presumption on my part if I were to attempt to tell an audience of gentlemen intimately acquainted with all branches of industry and commerce, such as I see before me, in what manner the practical details of the operations that we propose are to be carried out. I am absolutely ignorant both of trade and of commerce, and upon such matters I cannot venture to say a solitary word. But there is one direction in which I think it possible I may be of service — not much perhaps, but still of some,— because this matter, in the first place, involves the consideration of methods of education with which it has been my business to occupy myself during the greater part of my life; and, in the second place, it involves attention to some of those broad facts and laws of nature with which it has been my business to acquaint myself to the best of my ability. And what I think may be possible is this, that if I succeed in putting before you — as briefly as I can, but in clear and connected shape — what strikes me as the programme that we have eventually to carry out, and what are the indispensable conditions of success, that that proceeding, whether the conclusions at which I arrive be such as you approve or as you disapprove, will nevertheless help to clear the course. In this and in all complicated matters we must remember a saying of Bacon, which may be freely translated thus: "Consistent error is very often vastly more useful than muddle-headed truth." At any rate, if there be any error in the conclusions I shall put before you, I will do my best to make the error perfectly clear and plain.

Now, looking at the question of what we want to do in this broad and general way, it appears to me that it is necessary for us, in the first place, to amend and improve our system of primary education in such a fashion as will make it a proper preparation for the business of life. In the second place, I think we have to consider what measures may best be adopted for the development to its uttermost of that which may be called technical skill; and, in the third place, I think we have to consider what other matters there are for us to attend to, what other arrangements have to be kept carefully in sight in order that, while pursuing these ends, we do not forget that which is the end of civil existence, I mean a

stable social state without which all other measures are merely futile, and, in effect, modes of going faster to ruin.

You are aware — no people should know the fact better than Manchester people — that, within the last seventeen years, a vast system of primary education has been created and extended over the whole country. I had some part in the original organisation of this system in London, and I am glad to think that, after all these years, I can look back upon that period of my life as perhaps the part of it least wasted.

No one can doubt that this system of primary education has done wonders for our population; but, from our point of view, I do not think anybody can doubt that it still has very considerable defects. It has the defect which is common to all the educational systems which we have inherited — it is too bookish, too little practical. The child is brought too little into contact with actual facts and things, and as the system stands at present it constitutes next to no education of those particular faculties which are of the utmost importance to industrial life — I mean the faculty of observation, the faculty of working accurately, of dealing with things instead of with words. I do not propose to enlarge upon this topic, but I would venture to suggest that there are one or two remedial measures which are imperatively needed; indeed, they have already been alluded to by Mr. Acland. Those which strike me as of the greatest importance are two, and the first of them is the teaching of drawing. In my judgment, there is no mode of exercising the faculty of observation and the faculty of accurate reproduction of that which is observed, no discipline which so readily tests error in these matters, as drawing properly taught. And by that I do not mean artistic drawing; I mean figuring natural objects: making plans and sections, approaching geometrical rather than artistic drawing. I do not wish to exaggerate, but I declare to you that, in my judgment, the child who has been taught to make an accurate elevation, plan and section of a pint pot has had an admirable training in accuracy of eye and hand. I am not talking about artistic education. That is not the question. Accuracy is the foundation of everything else, and instruction in artistic drawing is something which may be put off till a later stage. Nothing has struck me more in the course of my life than the loss which persons, who are pursuing scientific knowledge of any kind, sustain from the difficulties which arise because they never have been taught elementary drawing; and I am glad to say that in Eton, a school of whose governing body I have the honour of being a member, we some years ago made drawing imperative on the whole school.

The other matter in which we want some systematic and good teaching is what I have hardly a name for, but which may best be explained as a sort of developed object lessons such as Mr. Acland adverted to. Anybody who knows his business in science can make anything subservient to that purpose. You know it was said of Dean Swift that he could write an admirable poem upon a broomstick, and the man who has a real knowledge of science can make the commonest object in the world subservient to an introduction to the principles and greater truths of natural knowledge. It is in that way that your science must be taught if it is to be of real service. Do not suppose any amount of book work, any repetition by rote of catechisms and other abominations of that kind are of value for our object. That is mere wasting of time. But take the commonest object and lead the child from that foundation to such truths of a higher order as may be within his grasp. With regard to drawing, I do not think there is any practical difficulty; but in respect to the scientific object lessons you want teachers trained in a manner different from that which now prevails.

If it is found practicable to add further training of the hand and eye by instruction in modelling or in simple carpentry, well and good. But I should stop at this point. The elementary schools are already charged with quite as much as they can do properly; and I do not believe that any good can come of burdening them with special technical instruction. Out of that, I think, harm would come.

Now let me pass to my second point, which is the development of technical skill. Everybody here is aware that at this present moment there is hardly a branch of trade or of commerce which does not depend, more or less directly, upon some department or other of physical science, which does not involve, for its successful pursuit, reasoning from scientific data. Our machinery, our chemical processes or dyeworks, and a thousand operations which it is not necessary to mention, are all directly and immediately connected with science. You have to look among your workmen and foremen for persons who shall intelligently grasp the modifications, based upon science, which are constantly being introduced into these industrial processes. I do not mean that you want professional chemists, or physicists, or mathematicians, or the like, but you want people sufficiently familiar with the broad principles which underlie industrial operations to be able to adapt themselves to new conditions. Such qualifications can only be secured by a sort of scientific instruction which occupies a midway place between those primary notions given in the elementary schools

and those more advanced studies which would be carried out in the technical schools.

You are aware that, at present, a very large machinery is in operation for the purpose of giving this instruction. I don't refer merely to such work as is being done at Owens College here, for example, or at other local colleges. I allude to the larger operations of the Science and Art Department, with which I have been connected for a great many years. I constantly hear a great many objections raised to the work of the Science and Art Department. If you will allow me to say so, my connection with that department — which, I am happy to say, remains, and which I am very proud of — is purely honorary; and, if it appeared to me to be right to criticise that department with merciless severity, the Lord President, if he were inclined to resent my proceedings, could do nothing more than dismiss me. Therefore you may believe that I speak with absolute impartiality. My impression is this, not that it is faultless, nor that it has not various defects, nor that there are not sundry *lacunæ* which want filling up; but that, if we consider the conditions under which the Department works, we shall see that certain defects are inseparable from those conditions. People talk of the want of flexibility of the Department, of its being bound by strict rules. Now, will any man of common sense who has had anything to do with the administration of public funds or knows the humour of the House of Commons on these matters — will any man who is in the smallest degree acquainted with the practical working of State departments of any kind, imagine that such a department could be other than bound by minutely defined regulations? Can he imagine that the work of the department should go on fairly and in such a manner as to be free from just criticism, unless it were bound by certain definite and fixed rules? I cannot imagine it.

The next objection of importance that I have heard commonly repeated is that the teaching is too theoretical, that there is insufficient practical teaching. I venture to say that there is no one who has taken more pains to insist upon the comparative uselessness of scientific teaching without practical work than I have; I venture to say that there are no persons who are more cognisant of these defects in the work of the Science and Art Department than those who administer it. But those who talk in this way should acquaint themselves with the fact that proper practical instruction is a matter of no small difficulty in the present scarcity of properly taught teachers, that it is very costly, and that, in some branches of science, there are other difficulties which I won't allude to. But it is a matter of fact that, wherever it has

been possible, practical teaching has been introduced, and has been made an essential element in examination; and no doubt if the House of Commons would grant unlimited means, and if proper teachers were to hand, as thick as blackberries, there would not be much difficulty in organising a complete system of practical instruction and examination ancillary to the present science classes. Those who quarrel with the present state of affairs would be better advised if, instead of groaning over the shortcomings of the present system, they would put before themselves these two questions — Is it possible under the conditions to invent any better system? Is it possible under the conditions to enlarge the work of practical teaching and practical examination which is the one desire of those who administer the department? That is all I have to say upon that subject.

Supposing we have this teaching of what I may call intermediate science, what we want next is technical instruction, in the strict sense of the word technical; I mean instruction in that kind of knowledge which is essential to the successful prosecution of the several branches of trade and industry. Now, the best way of obtaining this end is a matter about which the most experienced persons entertain very diverse opinions. I do not for one moment pretend to dogmatise about it; I can only tell you what the opinion is that I have formed from hearing the views of those who are certainly best qualified to judge, from those who have tested the various methods of conveying this instruction. I think we have before us three possibilities. We have, in the first place, trade schools — I mean schools in which branches of trade are taught. We have, in the next place, schools attached to factories for the purpose of instructing young apprentices and others who go there, and who aim at becoming intelligent workmen and capable foremen. We have, lastly, the system of day classes and evening classes. With regard to the first there is this objection, that they can be attended only by those who are not obliged to earn their bread, and consequently that they will reach only a very small fraction of the population. Moreover, the expense of trade schools is enormous, and those who are best able to judge assure me that, inasmuch as the work which they do is not done under conditions of pecuniary success or failure, it is apt to be too amateurish and speculative, and that it does not prepare the worker for the real conditions under which he will have to carry out his work. In any case, the fact that the schools are very expensive, and the fact that they are accessible only to a small portion of the population, seem to me to constitute a very serious objection to them. I suppose the best of all possible organisa-

tions is that of a school attached to a factory, where the employer has an interest in seeing that the instruction given is of a thoroughly practical kind, and where the pupils pass gradually by successive stages to the position of actual workmen. Schools of this kind exist in various parts of the country, but it is obvious that they are not likely to be reached by any large part of the population; so that it appears to me we are shut up practically to schools accessible to those who are earning their bread, and in such cases they must be essentially evening classes. I am strongly of opinion that classes of this kind do an immense amount of good; that they have this admirable quality, that they involve voluntary attendance, take no man out of his position, but enable any who chooses, to make the best of the position he happens to occupy.

Suppose that all these things are desirable, what is the best way of obtaining them? I must confess that I have a strong prejudice in favour of carrying out undertakings of this kind, which at first, at any rate, must be to a great extent tentative and experimental, by private effort. I don't believe that the man lives at this present time who is competent to organise a final system of technical education. I believe that all attempts made in that direction must for many years to come be experimental, and that we must get to success through a series of blunders. Now that work is far better performed by private enterprise than in any other way. But there is another method which I think is permissible, and not only permissible but highly recommendable in this case, and that is the method of allowing the locality itself in which any branch of industry is pursued to be its own judge of its own wants, and to tax itself under certain conditions for the purpose of carrying out any scheme of technical education adapted to its needs. I am aware that there are many extreme theorists of the individualist school who hold that all this is very wicked and very wrong, and that by leaving things to themselves they will get right. Well, my experience of the world is that things left to themselves don't get right. I believe it to be sound doctrine that a municipality — and the State itself for that matter — is a corporation existing for the benefit of its members, and that here, as in all other cases, it is for the majority to determine that which is for the good of the whole, and to act upon that. That is the principle which underlies the whole theory of government in this country, and if it is wrong we shall have to go back a long way. But you may ask me, "This process of local taxation can only be carried out under the authority of an Act of Parliament, and do you propose to let any municipal-

ity or any local authority have *carte blanche* in these matters; is the Legislature to allow it to tax the whole body of its members to any extent it pleases and for any purposes it pleases?" I should reply, certainly not.

Let me point out to you that at this present moment it passes the wit of man, so far as I know, to give a legal definition of technical education. If you expect to have an Act of Parliament with a definition which shall include all that ought to be included, and exclude all that ought to be excluded, I think you will have to wait a very long time. I imagine the whole matter is in a tentative state. You don't know what you will be called upon to do, and so you must try and you must blunder. Under these circumstances it is obvious that there are two alternatives. One of these is to give a free hand to each locality. Well, it is within my knowledge that there are a good many people with wonderful, strange, and wild notions as to what ought to be done in technical education, and it is quite possible that in some places, and especially in small places, where there are few persons who take an interest in these things, you will have very remarkable projects put forth, and in that case the sole court of appeal for those taxpayers, who did not approve of such projects, would be a court of law. I suppose the judges would have to settle what is technical education. That would not be an edifying process, I think, and certainly it would be a very costly one. The other alternative is the principle adopted in the bill of last year now abandoned. I don't say whether the bill was right or wrong in detail. I am dealing now only with the principle of the bill, which appears to me to have been very often misunderstood. It has been said that it gave the whole of technical education into the hands of the Science and Art Department. It appears to me nothing could be more unfounded than that assertion. All I understand the Government proposed to do was to provide some authority who should have power to say in case any scheme was proposed, "Well, this comes within the four corners of the Act of Parliament, work it as you like;" or if it was an obviously questionable project, should take upon itself the responsibility of saying, "No, that is not what the Legislature intended; amend your scheme." There was no initiative, no control; there was simply this power of giving authority to decide upon the meaning of the Act of Parliament to a particular department of the State, whichever it might be; and it seems to me that that is a very much simpler and better process than relegating the whole question to the law courts. I think that here, or anywhere else, people must be extremely sanguine if they suppose that the House of Commons and the House

of Lords will ever dream of giving any local authority unlimited power to tax the inhabitants of a district for any object it pleases. I should say that was not in the range of practical politics. Well, I put that before you as a matter for your consideration.

Another very important point in this connection is the question of the supply of teachers. I should say that is one of the greatest difficulties which beset the whole problem before us. I do not wish in the slightest degree to criticise the existing system of preparing teachers for ordinary school work. I have nothing to say about it. But what I do wish to say, and what I trust I may impress on your minds firmly is this, that for the purpose of obtaining persons competent to teach science or to act as technical teachers, a different system must be adopted. For this purpose a man must know what he is about thoroughly, and be able to deal with his subject as if it were the business of his ordinary life. For this purpose, for the obtaining of teachers of science and of technical classes, the system of catching a boy or girl young, making a pupil teacher of him, compelling the poor little mortal to pour from his little bucket, into a still smaller bucket, that which has just been poured into it out of a big bucket; and passing him afterwards through the training college, where his life is devoted to filling the bucket from the pump from morning till night, without time for thought or reflection, is a system which should not continue. Let me assure you that it will not do for us, that you had better give the attempt up than try that system. I remember somewhere reading of an interview between the poet Southey and a good Quaker. Southey was a man of marvellous powers of work. He had a habit of dividing his time into little parts each of which was filled up, and he told the Quaker what he did in this hour and that, and so on through the day until far into the night. The Quaker listened, and at the close said, "Well, but friend Southey, when dost thee think?" The system which I am now adverting to is arraigned and condemned by putting that question to it. When does the unhappy pupil teacher, or over-drilled student of a training college, find any time to think? I am sure if I were in their place I could not. I repeat, that kind of thing will not do for science teachers. For science teachers must have knowledge, and knowledge is not to be acquired on these terms. The power of repetition is, but that is not knowledge. The knowledge which is absolutely requisite in dealing with young children is the knowledge you possess, as you would know your own business, and which you can just turn about as if you were explaining to a boy a matter of everyday life.

So far as science teaching and technical education are con-

cerned, the most important of all things is to provide the machinery for training proper teachers. The Department of Science and Art has been at that work for years and years, and though unable under present conditions to do so much as could be wished, it has, I believe, already begun to leaven the lump to a very considerable extent. If technical education is to be carried out on the scale at present contemplated, this particular necessity must be specially and most seriously provided for. And there is another difficulty, namely, that when you have got your science or technical teacher it may not be easy to keep him. You have educated a man — a clever fellow very likely — on the understanding that he is to be a teacher. But the business of teaching is not a very lucrative and not a very attractive one, and an able man who has had a good training is under extreme temptations to carry his knowledge and his skill to a better market, in which case you have had all your trouble for nothing. It has often occurred to me that probably nothing would be of more service in this matter than the creation of a number of not very large bursaries or exhibitions, to be gained by persons nominated by the authorities of the various science colleges and schools of the country — persons such as they thought to be well qualified for the teaching business — and to be held for a certain term of years, during which the holders should be bound to teach. I believe that some measure of this kind would do more to secure a good supply of teachers than anything else. Pray note that I do not suggest that you should try to get hold of good teachers by competitive examination. That is not the best way of getting men of that special qualification. An effectual method would be to ask professors and teachers of any institution to recommend men who, to their own knowledge, are worthy of such support, and are likely to turn it to good account.

I trust I am not detaining you too long; but there remains yet one other matter which I think is of profound importance, perhaps of more importance than all the rest, on which I earnestly beg to be permitted to say some few words. It is the need, while doing all these things, of keeping an eye, and an anxious eye, upon those measures which are necessary for the preservation of that stable and sound condition of the whole social organism which is the essential condition of real progress, and a chief end of all education. You will all recollect that some time ago there was a scandal and a great outcry about certain cutlasses and bayonets which had been supplied to our troops and sailors. These warlike implements were polished as bright as rubbing could make them; they were very well sharpened; they looked lovely. But when they were applied to the test of the work of war they broke and were

bent, and proved more likely to hurt the hand of him that used them than to do any harm to the enemy. Let me apply that analogy to the effect of education, which is a sharpening and polishing of the mind. You may develop the intellectual side of people as far as you like, and you may confer upon them all the skill that training and instruction can give; but, if there is not, underneath all that outside form and superficial polish, the firm fibre of healthy manhood and earnest desire to do well, your labour is absolutely in vain.

Let me further call your attention to the fact that the terrible battle of competition between the different nations of the world is no transitory phenomenon, and does not depend upon this or that fluctuation of the market, or upon any condition that is likely to pass away. It is the inevitable result of that which takes place throughout nature and affects man's part of nature as much as any other — namely, the struggle for existence, arising out of the constant tendency of all creatures in the animated world to multiply indefinitely. It is that, if you look at it, which is at the bottom of all the great movements of history. It is that inherent tendency of the social organism to generate the causes of its own destruction, never yet counteracted, which has been at the bottom of half the catastrophes which have ruined States. We are at present in the swim of one of those vast movements in which, with a population far in excess of that which we can feed, we are saved from a catastrophe, through the impossibility of feeding them, solely by our possession of a fair share of the markets of the world. And in order that that fair share may be retained, it is absolutely necessary that we should be able to produce commodities which we can exchange with food-growing people, and which they will take, rather than those of our rivals, on the ground of their greater cheapness or of their greater excellence. That is the whole story. And our course, let me say, is not actuated by mere motives of ambition or by mere motives of greed. Those doubtless are visible enough on the surface of these great movements, but the movements themselves have far deeper sources. If there were no such things as ambition and greed in this world, the struggle for existence would arise from the same causes.

Our sole chance of succeeding in a competition, which must constantly become more and more severe, is that our people shall not only have the knowledge and the skill which are required, but that they shall have the will and the energy and the honesty, without which neither knowledge nor skill can be of any permanent avail. This is what I mean by a stable social condition,

because any other condition than this, any social condition in which the development of wealth involves the misery, the physical weakness, and the degradation of the worker, is absolutely and infallibly doomed to collapse. Your bayonets and cutlasses will break under your hand, and there will go on accumulating in society a mass of hopeless, physically incompetent, and morally degraded people, who are, as it were, a sort of dynamite which, sooner or later, when its accumulation becomes sufficient and its tension intolerable, will burst the whole fabric.

I am quite aware that the problem which I have put before you and which you know as much about as I do, and a great deal more probably, is one extremely difficult to solve. I am fully aware that one great factor in industrial success is reasonable cheapness of labour. That has been pointed out over and over again, and is in itself an axiomatic proposition. And it seems to me that of all the social questions which face us at this present time, the most serious is how to steer a clear course between the two horns of an obvious dilemma. One of these is the constant tendency of competition to lower wages beyond a point at which man can remain man — below a point at which decency and cleanliness and order and habits of morality and justice can reasonably be expected to exist. And the other horn of the dilemma is the difficulty of maintaining wages above this point consistently with success in industrial competition. I have not the remotest conception how this problem will eventually work itself out; but of this I am perfectly convinced, that the sole course compatible with safety lies between the two extremes; between the Scylla of successful industrial production with a degraded population, on the one side, and the Charybdis of a population, maintained in a reasonable and decent state, with failure in industrial competition, on the other side. Having this strong conviction, which, indeed, I imagine must be that of every person who has ever thought seriously about these great problems, I have ventured to put it before you in this bare and almost cynical fashion because it will justify the strong appeal, which I make to all concerned in this work of promoting industrial education, to have a care, at the same time, that the conditions of industrial life remain those in which the physical energies of the population may be maintained at a proper level; in which their moral state may be cared for; in which there may be some rays of hope and pleasure in their lives; and in which the sole prospect of a life of labour may not be an old age of penury.

These are the chief suggestions I have to offer to you, though I have omitted much that I should like to have said, had time

permitted. It may be that some of you feel inclined to look upon them as the Utopian dreams of a student. If there be such, let me tell you that there are, to my knowledge, manufacturing towns in this country, not one-tenth the size, or boasting one-hundredth part of the wealth, of Manchester, in which I do not say that the programme that I have put before you is completely carried out, but in which, at any rate, a wise and intelligent effort had been made to realise it, and in which the main parts of the programme are in course of being worked out. This is not the first time that I have had the privilege and pleasure of addressing a Manchester audience. I have often enough, before now, thrown myself with entire confidence upon the hard-headed intelligence and the very soft-hearted kindness of Manchester people, when I have had a difficult and complicated scientific argument to put before them. If, after the considerations which I have put before you — and which, pray be it understood, I by no means claim particularly for myself, for I presume they must be in the minds of a large number of people who have thought about this matter — if it be that these ideas commend themselves to your mature reflection, then I am perfectly certain that my appeal to you to carry them into practice, with that abundant energy and will which have led you to take a foremost part in the great social movements of our country many a time beforehand, will not be made in vain. I therefore confidently appeal to you to let those impulses once more have full sway, and not to rest until you have done something better and greater than has yet been done in this country in the direction in which we are now going. I heartily thank you for the attention which you have been kind enough to bestow upon me. The practice of public speaking is one I must soon think of leaving off, and I count it a special and peculiar honour to have had the opportunity of speaking to you on this subject to-day.

THE END.

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